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Art. I.—*Preliminary Notice of Victorian Earthworms, Part II. The genus Perichæta.*

(With Plates II, III, IV, V, VI, VII.)

By W. Baldwin Spencer, M.A.

Professor of Biology in the University of Melbourne.

[Read March 10, 1892.]

This account includes the description of twenty-two species of the genus Perichæta, which have up to the present time been collected in Victoria. Two of these, *Perichæta dorsalis* and *bakeri*, have been previously described by Mr. J. J. Fletcher, who obtained them from Gippsland. My own collection has been made in different parts of Victoria, and especially in the South Eastern district, where Gippsland is peculiarly rich. As in the case of the genera Cryptodrilus and Megascolides, so in that of Perichæta, the forms described are at present, for the sake of convenience, referred to the one genus, though this will undoubtedly have to be broken up, and at the same time, certain forms provisionally as yet referred to it, may have to be placed under other existing genera. With this, Mr. Fletcher and myself will deal in our extended monograph. Sufficient details only are now given to serve for the identification of the species.

We have in Victoria only one species which is really widely distributed—this is *P. dorsalis*, which was first described by Fletcher from Warragul, Gippsland. Since then it has been obtained in West and South Gippsland, from the Otway district, from the Grampians, and from Creswick and Castlemaine. It is not only widely spread, but is also abundant in numbers, almost always forming the majority of specimens of any collection in West or South Gippsland especially. It is interesting to note that an allied form, *Perichæta stirlingi*, is apparently prevalent in South Australia.

The distribution of the former species is in marked contrast to that of most. Certain forms, such as *P. tanjilensis* and *yarraensis*, are characteristic of the Upper Yarra Valley especially. *Perichæta fielderi*, a very well marked form, has only come from Fern Tree Gully and Sassafras Gully and the hills outside Narre Warren, all of which localities lie within a small compass. *P. bakeri*, *copelandi*, and *obscura*, are characteristic of the Warragul district in Gippsland, and *P. dendyi* is an interesting form recorded as yet only from Healesville. *P. lateralis* has been found only in North West Victoria and is closely allied to the South Australian species *P. stirlingi*.

For valuable assistance in collecting, I am again indebted to Dr. Dendy, Rev. W. Fielder, and Messrs. French, Frost, Shephard, Hall, Steel, Mann, Copeland, Brittlebank, D. le Souëf, R. H. Anderson and H. Giles.

Unless otherwise stated, the description always refers to spirit specimens. Such structures as the accessory copulatory ones are only evident after preservation, and examination of numerous specimens shows that spirit exerts a uniform action upon these.

(1) *Perichæta copelandi*, sp. n. (Figs. 52, 53, 54, 76). Length of spirit specimen 5 inches, $\frac{3}{8}$ inch broad. Number of segments about 175.

Dark purple colour dorsally, with a darker median line.

Prostomium completely dovetailed into the peristomium, and marked by a median groove.

Clitellum not strongly marked, occupying segments 13–17, but not always the anterior part of 13 or the posterior of 17.

Setæ. The first setigerous segment has 10 on each side, after this and to the posterior end of the clitellum the number varies from 15–17. Behind segment 20, it varies from 23–25. On the last 6 or 7 segments the setæ are difficult to see. Dorsal and ventral median lines free of setæ.

Male pores on papillæ in segment 18, at the level of the interval between the two inner setæ of each side.

Oviduct pores on segment 14 anterior to, and at the level of the interval between the two inner setæ of each side.

Spermathecal pores, 5 pairs placed on the line between segments 4–9, very slightly dorsal of the level of the innermost setæ.

Accessory copulatory structures. A pair of elliptical tumid patches between segments 16 and 17, at the level of the interval between the inner two setæ of each side. A pair between segments 17 and 18, at the level of the interval between the second and third setæ of each side; a pair at the same level between segments 18 and 19, and another between segments 19 and 20. The male openings lie ventral of these structures and not dorsal, as in the case of the similar ones present in *P. bakeri.* A series of pairs of small elliptical patches marked by distinct pores on the very anterior margins of segments 9–13, each one slightly dorsal of the innermost setæ of its side. These patches in segment 9 are enlarged and include the openings of the spermathecæ. An additional pair, with similar relationships, may be present on segment 8.

Dorsal pores present, the first between segments 4 and 5.

Nephridiopores not visible externally.

Alimentary canal. Gizzard present in segment 5. No true calciferous glands, but vascular swellings are present in segments 9–15. Large intestine commences in segment 17.

Circulatory system. Single dorsal vessel, with the last pair of hearts in segment 12. No supra-intestinal vessel present.

Excretory system. Meganephric.

Reproductive system. Testes, two pairs in segments 10 and 11, into which the ciliated rosettes open.

Prostates long, coiled, and tubular, occupying segments 18-22.

Sperm sacs, three pairs attached respectively to the posterior wall of segment 9 and the anterior of segments 12 and 13. Saccular in form.

Ovaries in segment 13, with oviducts opening into the same segment.

Spermathecæ, 5 pairs present in segments 5–9, each consisting of a large sac and short diverticulum.

Habitat. Warragul district. I have associated with this characteristic Gippsland perichæte the name of Mr. Hugh Copeland, to whom I am much indebted for frequent and valuable assistance in collecting.

(2) *Perichæta obscura*, sp. n. (Figs. 4, 5, 6, 70). Length of spirit specimen $2\frac{3}{4}$ inches, about $\frac{1}{8}$ inch broad. Number of segments 90–100.

Prostomium completely dovetailed into the peristomium.

Clitellum complete, and extending over segments 14–16, together with the posterior part of 13.

Setæ, from 9–11 on each side in front of the clitellum; behind this, 10–12 each side. Dorsally and ventrally there is a median space free of setæ.

Male pores on segment 18 on papillæ, on a level with the second seta on each side.

Oviduct pores on segment 14 anterior to, and very slightly ventral of, the level of the innermost setæ.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9, at the level of the second setæ of each side.

Accessory copulatory structures. A pair of elliptical tumid patches between segments 16 and 17, at the level of the interval between the two inner setæ of each side. A pair at the same level on the anterior part of segment 18, and another between segments 17 and 18, at the level of the interval between the second and third setæ of each side. A swollen tumid ridge occupies the posterior part ventrally of segment 18, and the anterior of segment 19, extending outwards as far as the level of the third seta of each side. A ridge on the posterior part of segment 19, and anterior of segment 20, extending outwards as far as the level of the second seta of each side. These structures, and especially the two on each side immediately in front of the male openings, are very characteristic.

Dorsal pores present, the first between segments 4 and 5.

Alimentary canal. Gizzard in segment 5. No true calciferous glands present, but vascular swellings in segments 12–15; those in 14 and 15 being especially large. Large intestine commencing in segment 17.

Circulatory system. Dorsal vessel single; last heart in segment 12. Those in segments 10, 11, 12 large; those in segments 7, 8, 9 small. Supra-intestinal vessel in segments 9–12.

Excretory system. Meganephric.

Reproductive system. Testes, two pairs in segments 10 and 11, into which open the rosettes.

Prostates tubular, coiled, extending through segments 17, 18, and 19.

Sperm sacs, two pairs attached respectively to the anterior wall of segment 12, and the posterior of segment 9.

Ovaries in segment 13, the oviducts opening into the same segment.

Spermathecæ, five pairs, in segments 5–9. Each consisting of a sac, with a diverticulum half the length of the sac.

Habitat. Warragul, Fern Tree Gully.

(3) *Perichæta sylvatica*, sp. n. (Figs. 34, 35, 36, 68). Length of spirit specimen 3 inches, less than ⅛ inch broad. Number of segments about 100.

Prostomium not completely dovetailed into the peristomium (about three-quarters). The peristomium marked by a fairly distinct median ventral cleft.

Clitellum occupying segments 14, 15, 16, with the posterior part of 13, and the anterior of 17.

Setæ, 12 on each side, except in the first two setigerous segments, where there are 10.

Male pores on segment 18, slightly ventral of the level of the second setæ.

Oviduct pores on segment 14 ventral of, and very slightly anterior to, the innermost setæ.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9, each at the level of the innermost seta.

Accessory copulatory structures. Two pairs of faintly marked circular patches on segments 16 and 17, at the level of the interval between the two inner setæ of each side. A pair of well marked elliptical patches on segment 10, posterior to, and at the level of, the interval between the second and third setæ of each side.

Dorsal pores present, the first between segments 5 and 6.

Alimentary canal. Gizzard in segment 5. Three pairs of well marked calciferous glands present in segments 10, 11, and 12. Large intestine commencing in segment 15.

Circulatory system. Dorsal vessel single, the last heart in segment 12.

Excretory system. Plectonephric.

Reproductive system. Testes in segments 10 and 11, rosettes opening into the same segments.

Prostates small, flattened and bilobed, but with a single duct. In segment 18.

Sperm sacs, two pairs, one attached to the anterior wall of segment 12, the other to the posterior wall of segment 9. Saccular in form.

Ovaries in segment 13, the oviducts opening into the same segment.

Spermathecæ, five pairs, in segments 5–9. Each consisting of a sac, with a diverticulum about the same length as the latter.

Habitat. Fern Tree Gully.

(4) *Perichæta hoggii*, sp. n. (Figs. 28, 29, 30, 80). Length of spirit specimen 4½ inches, ⅛ inch broad. Number of segments about 125.

Prostomium not completely dovetailed into the peristomium (about one-half). The latter has a distinct median ventral cleft.

Clitellum occupying the posterior part of segment 13, together with the segments 14, 15, 16, and the anterior part of segment 17.

Setæ, except the first two segments, 12 on each side.

Male pores on papillæ in segment 18, at the level of the innermost seta on each side.

Oviduct pores on segment 14 ventral of, and anterior to, the level of the innermost setæ.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 8 and 9, at the level of the innermost setæ.

Accessory copulatory structures. Paired tumid patches slightly anterior to, and at the level of, the innermost setæ in segments 20, 21 and 22. A median ventral ridge, occupying the space between the two innermost papillæ, is present on segments 17 and 19. On segments 20, 21, and 22, median ventral ridges are usually present, connecting the circular patches across the median line.

Dorsal pores present, the first between segments 4 and 5.

Alimentary canal. Gizzard in segment 5. True calciferous glands in segments 10, 11, 12. Large intestine commencing in segment 15.

Circulatory system. Single dorsal vessel. Last heart in segment 12. Small hearts in segments 6–9.

Excretory system. Plectonephric.

Reproductive system. Testes in segments 10 and 11, with rosettes opening into the same segments.

Prostates small, flattened, and bilobed with a single duct.

Sperm sacs, two pairs; one attached to the anterior wall of segment 12, the other to the posterior wall of segment 9.

Ovaries in segment 13, oviducts opening into the same segment.

Spermathecæ, 5 pairs, in segments 5–9. Each with a sac and diverticulum more than three-quarters the length of the former.

Habitat. Mt. Macedon and Healesville (Dr. Dendy).

The first specimens were found at Mount Macedon, whilst collecting with Mr. H. R. Hogg, to whom I am indebted for valuable assistance, and whose name is associated with this form.

(5) *Perichæta hallii* (Figs. 40, 41, 42, 69). Length of spirit specimen $1\frac{3}{8}$ inches, a little more than $\frac{1}{16}$ inch broad. Number of segments about 100.

Prostomium not completely dovetailed into the peristomium (about three-quarters). The peristomium with a distinct median ventral cleft.

Clitellum not very strongly developed, lighter coloured than the surrounding parts, and occupying segments 13–17.

Setæ somewhat difficult to see. In front of clitellum, 12 or 13 on each side; behind, 12–16 on each side.

Male pores on very strongly marked papillæ on segment 18, the openings being slightly dorsal to the level of the innermost setæ. Between the papillæ is a deep depression extending on to segments 17 and 19.

Oviduct pores on segment 14.

Spermathecal pores, five pairs.

Accessory copulatory structures. Three pairs of well marked elliptical tumid patches, each with a median linear depression on the posterior portions of segments 9, 10, and 11, and extending over a space equal to that between setæ 1 and 3 on each side. A smaller patch on the anterior part of the segments 9 and 10, confluent with the larger posterior one, but not so strongly marked.

Dorsal pores present, the first between segments 4 and 5.

Alimentary canal. Gizzard in segment 5. True calciferous glands present in segments 10, 11, and 12. Large intestine commencing in segment 17.

Circulatory system. Dorsal vessel single. Last heart in segment 12.

Excretory system. Plectonephric.

Reproductive system. Testes in segments 10 and 11, into which the rosettes open. The same segments are filled with sperm.

Prostates small, flattened, and bilobed, but with a single duct on each side, in segment 18.

Sperm sacs attached to the anterior wall of segment 12, and the posterior wall of segment 9, with a smaller pair attached to the anterior wall of segment 14.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, 5 pairs, in segments 5, 6, 7, 8, and 9. Each consisting of a sac, with a diverticulum more than half as long as the former.

Habitat. Castlemaine. Collected by Mr. T. S. Hall, M.A.

(6) *Perichæta rubra*, sp. n. (Figs. 25, 26, 27). Length of spirit specimen $2\frac{1}{4}$ inches, breadth about $\frac{1}{8}$ inch. Number of segments 80–90.

Prostomium not completely dovetailed into the peristomium (about $\frac{1}{2}$). The peristomium with a distinct median ventral cleft.

Clitellum distinct and complete, occupying segments 14–16.

Setæ, in front of the clitellum 10 each side, behind 12.

Male pores on distinct papillæ on segment 18, at the level of the third seta of each side.

Oviduct pores on segment 14 anterior to, and ventral of, the first setæ.

Spermathecal pores, 5 pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9, at the level of the second seta of each side.

Accessory copulatory structures. Median ventral ridges occupying the anterior portions of segments 17, 19, 20, 21, 22 and 23. On segment 10, two strongly marked circular patches, with central depressions, placed posterior to the setæ and at the level of the interval between the second and third setæ. On segments 6, 7, 8 and 9 in the median ventral space devoid of setæ, and anterior to the level of the latter, are pairs of closely apposed circular tumid patches, each with a central pore-like depression. On segment 5, a median ventral patch.

Dorsal pores present, the first between segments 4 and 5.

Alimentary canal. Gizzard in segment 5. True calciferous glands in segments 10, 11 and 12. Large intestine commencing in segment 15.

Circulatory system. Dorsal vessel single. Last heart in segment 12.

Excretory system. Plectonephric.

Reproductive system. Testes, two pairs in segments 10 and 11, into which the rosettes open.

Prostates small, flattened, and bilobed, but with a single duct in segment 18.

Sperm sacs attached to the posterior wall of segment 9, the anterior of segment 12, and a small pair to the anterior of segment 14.

Ovaries in segment 13, with oviducts opening into the same segment.

Spermathecæ, five pairs, in segments 5–9. Each consisting of a large sac, with a diverticulum of about the same length as the sac.

Habitat. Tallarook, Goulburn River. Collected by Mr. A. H. S. Lucas. This is locally known as the "red worm."

(7) *Perichæta frenchii*, sp. n. (Figs. 31, 32, 33, 79). Length of spirit specimen 2–4 inches, breadth about ⅛ inch. Number of segments 110.

Spirit specimens are dark purple colour in front of the clitellum, save on the mid-ventral surface; dark purple median dorsal line; the rest of the body a dirty white.

Prostomium not completely dovetailed into the peristomium (about half). The peristomium marked by a distinct median ventral cleft.

Clitellum occupying segments 13–16, together with sometimes the anterior part of 17 dorsally.

Setæ, 10 each side in front of the clitellum, behind this 12 each side.

Male pores on papillæ on segment 18, at the level of the interval between the two inner setæ of each side. A distinct depression between the two papillæ.

Oviduct pores on a small elliptical patch on segment 14, anterior to, and slightly ventral of, the innermost setæ.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9. at the level of the innermost setæ on each side.

Accessory copulatory structures. Median ventral ridges, with linear depressions on the anterior parts of segments 19, 20, 21 and 22. Median ventral ridges on the posterior parts of segments 9 and 10; the anterior of the two, small.

Dorsal pores present, the first between segments 4 and 5.

Alimentary canal. Gizzard in segment 5. True calciferous glands in segments 10, 11 and 12. Large intestine commencing in segment 15.

Circulatory system. Dorsal vessel single, the last heart in segment 12.

Excretory system. Plectonephric.

Reproductive system. Testes in segments 10 and 11, rosettes in the same segments.

Prostates flattened, bilobed, one half in segment 18, the other in segment 19; each half with a short separate duct, the two uniting on each side in segment 18.

Sperm sacs attached to the posterior wall of segment 9, and the anterior of segment 12. Saccular in form.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, five pairs, in segments 5–9. Each consisting of a sac, with a diverticulum longer than the latter, and terminating in a slightly swollen part.

Habitat. Loch, S. Gippsland; Narre Warren, Waratah Bay (Mr. W. Mann).

Found abundantly under logs at Narre Warren by Mr. French and myself. I have much pleasure in associating with this the name of Mr. French, the Government Entomologist of Victoria, to whom I am much indebted for frequent and valuable assistance. This is one of those forms which make burrows, coming to the surface under logs and stones, in which position the burrow lies open, the upper surface being closed in by the log or stone.

(8) *Perichæta steelii*, sp. n. (Figs. 37, 38, 39). Length of spirit specimen 2½ inches, breadth about ⅛ inch. Number of segments about 120.

Prostomium incompletely dovetailed into the peristomium (about ¾). The peristomium marked by a distinct median ventral cleft.

Body dark purple-brown at the anterior end, with a dark median dorsal line along the body. Light brown behind the clitellum, except the dorsal portion close to the latter.

Setæ. The first 3 segments have 11 on each side, after this there are 12 setæ on each side.

Male pores on segment 12, at the level of the innermost setæ, but not on papillæ.

Oviduct pores on segment 14.

Spermathecal pores, 5 pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9, at the level of the second seta of each side.

Accessory copulatory structures not developed, except a slight median ventral ridge on segment 17.

Dorsal pores present, the first between segments 3 and 4.

Alimentary canal. Gizzard in segment 5. True calciferous glands in segments 10, 11 and 12. Large intestine commencing in segment 15.

Circulatory system. Dorsal vessel single. Hearts in segments 5–12, the last three large.

Excretory system. Plectonephric.

Reproductive system. Testes in segments 10 and 11, into which the rosettes open.

Prostates small, flattened, bilobed, but with a single duct in segment 18.

Sperm sacs attached to the anterior wall of segment 12, and the posterior of segment 9.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, five pairs, in segments 5–9. Each consisting of a sac, with a diverticulum about half the length of the former.

Habitat. Woodend. Collected by Mr. T. Steel.

(9) *Perichæta lateralis*, sp. n. (Figs. 55, 56, 57, 78). Length of spirit specimen 3–3½ inches, breadth less than ⅛ inch. Number of segments 126.

Prostomium not completely dovetailed into the peristomium (about ⅔). The prostomium marked by a median ventral cleft.

Clitellum complete, lighter coloured than the surrounding parts, occupying segments 14, 15 and 16.

Setæ in front of the clitellum, 10 or 11 each side; behind the clitellum, 10–12 each side.

Male pores on papillæ on segment 18, at the level of the interval between the second and third setæ of each side.

Oviduct pores on segment 14 placed on an elliptical patch, each opening almost at the same level as, and very slightly in front of, the innermost seta of each side.

Spermathecal pores, three pairs, between segments 6 and 7, 7 and 8, 8 and 9, at the level of the fifth seta of each side.

Accessory copulatory structures. A pair of small papillæ each immediately in front of, and confluent with, one of the papillæ bearing the male opening. In addition to these, which are very characteristic, two small pairs of tumid patches may be present at the level of the innermost setæ, one half on segments 18 and 19, the other half on segments

19 and 20, and another pair may be present at the level of the interval between the two inner rows of setæ on each side, half on segments 9 and 10.

Dorsal pores present, the first between segments 4 and 5.

Alimentary canal. Gizzard in segment 5. No true calciferous glands present, but vascular swellings present in segments 9–12. Large intestine commencing in segment 17.

Circulatory system. Dorsal vessel single. Hearts in segments 6–12.

Excretory system. Plectonephric.

Reproductive system. Testes, in pairs, in segments 10 and 11, with rosettes opening into the same segments.

Prostates flattened and elongate, with a somewhat mammillate surface. Each is leaf-shaped, the single duct running up the centre in the position of a mid-rib. Extending through segments 18–21.

Sperm sacs, three pairs, one pair on the anterior wall of segments 11 and 12; another on the posterior wall of segment 9. Sac-like in form.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, three pairs, in segments 7, 8 and 9. Each consisting of a sac, with a long coiled tubular diverticulum.

Habitat. Castlemaine (collected by Mr. T. S. Hall). Tallarook, Goulburn Valley (collected by Mr. A. H. S. Lucas.)

(10) *Perichæta dendyi*, sp. n. (Figs. 49, 50, 51, 77). Length of spirit specimen 2½ inches, breadth about ⅛ inch. Number of segments about 160. Colour yellowish when alive.

Prostomium completely dovetailed into the peristomium, the former being distinctly wedge-shaped.

Clitellum complete, occupying segments 14–16.

Setæ, as far back as segment 19, there are 6 on each side, arranged in pairs; segment 20 has 8 each side, in pairs, behind this increased to 10 each side, and at the posterior end vary from 7–10. The inner two on each side remain regular along the whole length of the body.

Male pores on slight papillæ on segment 18, at the level of the interval between the two inner setæ of each side.

Oviduct pores on segment 14.

Spermathecal pores, four pairs, between segments 5 and 6, 6 and 7, 7 and 8, 8 and 9, at the level of the innermost setæ.

Accessory copulatory structures. Narrow tumid ridges placed on the mid-ventral lines between segments 17 and 18, 18 and 19, 19 and 20. The single ridge may be divided into two halves, the centre of each half corresponding with the level of one of the innermost setæ. Special small tumid patches are constantly present, surrounding the openings of the two posterior pairs of spermathecæ.

Dorsal pores present, the first between segments 4 and 5.

Alimentary canal. Gizzard in segment 5. No true calciferous glands present. Vascular swellings in segments 9–12. Large intestine commencing in segment 18.

Circulatory system. Dorsal vessel single. Hearts in segments 8–12. A supra-intestinal vessel present in segments 9–12.

Excretory system. Meganephric.

Reproductive system. Two pairs of testes in segments 10 and 11, into which open the rosettes.

Prostates, flattened bodies folded over the intestine on each side in segment 18.

Sperm sacs, two pairs, one attached to the anterior wall of segment 12, the other to the posterior wall of segment 9. Sac-like in form.

Ovaries in segment 13, with oviducts opening into the same segments.

Spermathecæ, four pairs, in segments 6, 7, 8 and 9. Each consisting of a long sac, with a very short diverticulum at its base.

Habitat. Healesville (collected by Dr. Dendy), living in rotten logs.

I have much pleasure in associating with this the name of Dr. Dendy.

(11) *Perichæta lochensis,* sp. n. (Figs. 1, 2, 3). Length of spirit specimen 3 inches, breadth about $\frac{1}{8}$ inch.

Prostomium not completely dovetailed into the peristomium (about $\frac{3}{4}$).

Clitellum well-marked and complete, extending over segments 14–16, and including also the posterior part of segment 13.

Setæ; the usual number on each side, as far back as the 17th segment, is 9; there may occasionally be 11; after and including the 19th segment there are 10. A small posterior

part of the body, distinct from the rest by its lighter colour and flattened shape, dorso-ventrally, has 16–19 setæ on each side.

Male pores on slight papillæ on segment 18, at the level of the interval between the two inner setæ of each side.

Female pores on segment 14 anterior to, and ventral of, the level of the two innermost setæ.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9, difficult to see.

Accessory copulatory structures. Segments 17 and 18 have their mid-ventral parts tumid. A special swollen part lies immediately in front of the male opening on each side, and there are tumid ridges ventrally between segments 18 and 19, 19 and 20, but these are not strongly marked.

Dorsal pores present.

Alimentary canal. Gizzard in segment 5. No true calciferous glands, but vascular swellings are present in segments 12–15. Large intestine commencing in segment 17.

Circulatory system. Dorsal vessel single. Hearts in segments 8–12, the first two being small.

Excretory system. Meganephric. Each nephridium has a large sac.

Reproductive system. Two pairs of testes in segments 10 and 11, into which the rosettes open.

Prostates coiled, tubular, occupying segments 18–21.

Sperm sacs, two pairs, one attached to the anterior wall of segment 12, the other to the posterior wall of segment 9.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, 5 pairs, in segments 5, 6, 7, 8, and 9, each consisting of a sac and diverticulum less than half the length of the former.

Habitat. Loch, S. Gippsland, under logs.

(12) *Perichæta dubia*, sp. n. (Figs. 46, 47, 48, 67). Length of spirit specimen $1\frac{3}{4}$ inches, breadth $\frac{1}{8}$ inch. Number of segments, about 100.

Prostomium completely dovetailed into the peristomium.

Clitellum extending over segments 13–17; lighter colour than the surrounding parts; not thick and glandular, and scarcely noticeable ventrally.

Setæ. The first setigerous segment has 6 on each side, the 15 following ones have 8; behind this the number varies from 9–12.

Male pores on papillæ on segment 18, at the level of the interval between the two inner setæ of each side.

Oviduct pores on segment 14 slightly anterior to, and very nearly on, the same level as the innermost setæ of each side.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9, at the level of the intervals between the two inner setæ of each side.

Accessory copulatory structures. These resemble somewhat those of *P. bakeri*, but the two forms may be distinguished by the position of the spermathecal pores and the form of the prostate. Between segments 17 and 18, 18 and 19, and 19 and 20, are three pairs of elliptical tumid patches, nearer to the median line than the male pores.

Dorsal pores present, the first between segments 4 and 5.

Alimentary canal. Gizzard in segment 5. No true calciferous glands, but vascular swellings in segments 9–14. Large intestine commencing in segment 18.

Circulatory system. Single dorsal blood-vessel. Hearts in segments 5–12, those in segments 5–8, small. No continuous supra-intestinal vessel, but one in each of the segments 12–8 (?), which is connected with the dorsal vessel in the posterior part of the segment, and ends blindly in the anterior part.

Excretory system. Meganephric.

Reproductive system. Two pairs of testes in segments 10 and 11, into which the rosettes open.

Prostates coiled and tubular, extending through segments 18 and 19, the blind end being in segment 18.

Sperm sacs, two pairs, one attached to the anterior wall of segment 12, the other to the posterior wall of segment 9.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, five pairs, in segments 5–9. Each consisting of a long sac with a short diverticulum, about $\frac{1}{3}$ the length of the former.

Habitat. S. Warragul (collected by Mr. W. Mann).

(13) *Perichæta walhallæ*, sp. n. (Figs. 43, 44, 45, 66). Length of spirit specimen 1 inch, width slightly less than $\frac{1}{8}$ inch. Number of segments 88.

The form of the body is bluntly tapering at both ends. There is a median broad dark purple-brown band starting immediately behind the clitellum, and running back half way to the posterior end. In the median third of the body

the lateral surfaces are of the same colour, but chequered with little rectangular light areas.

The prostomium is not completely dovetailed into the peristomium (about ½).

Clitellum well marked, tumid and complete, occupying segments 14–16.

Setæ, in front of the clitellum, 10 on each side; behind, 12.

Male pores on segment 18, at the level of the interval between the two inner setæ of each side. Between the two openings a ridge runs across the mid-ventral surface, with a depression both in front of, and behind, it.

Oviduct pores on a small elliptical patch on segment 14, anterior to the level of the setæ.

Spermathecal pores difficult to see externally.

Accessory copulatory structures. None present.

Alimentary canal. Gizzard in segment 5. No true calciferous glands. Large intestine commencing in segment 15 (?)

Circulatory system. Dorsal vessel single. Last heart in segment 12.

Excretory system. Meganephric.

Reproductive system. Two pairs of testes in segments 10 and 11; rosettes opening into the same segments.

Prostates small, tubular, coiled, in segment 18.

Sperm sacs, one pair, attached to the anterior wall of segment 12. Sac-like in form.

Ovaries in segment 13, with oviducts opening into the same segment.

Spermathecæ, five pairs, in segments 5–9. Each consisting of a long sac with a short diverticulum.

Habitat. Walhalla (collected by Dr. Dendy).

I have, unfortunately, only one specimen (a mature one) of this form. But the shape and colouration of the body, together with the absence of accessory copulatory structures, render it so distinct from other forms that I have ventured to distinguish it specifically.

(14) *Perichæta dicksonia*, sp. n. (Figs. 7, 8, 9). Length of spirit specimens 2 inches, width less than ⅛ inch.

Prostomium completely dovetailed into the peristomium, which is marked by a median ventral cleft.

Clitellum well marked, complete, occupying segments 14–16.

Setæ, 10 on each side in front of the clitellum; 11 in the middle of the body. The rows are regularly arranged along the body.

Male pores on well marked papillæ on segment 18, at the level of the second seta of each side.

Oviduct pores on segment 14 anterior to, and slightly ventral of, the level of the innermost setæ.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9; slightly dorsal of the level of the innermost setæ of each side.

Accessory copulatory structures. Two well marked elliptical tumid patches, one immediately in front of, and the other immediately behind, the male openings. The first half on segments 17 and 18, and the second half on segments 18 and 19.

Dorsal pores present, the first between segments 4 and 5.

Nephridiopores on the anterior margin of the segments, at the level of the sixth seta of each side, commencing on the third segment.

Alimentary canal. Gizzard in segment 5. No true calciferous glands. Large intestine commencing in segment 17.

Circulatory system. Dorsal vessel single. Hearts in segments 6–12.

Excretory system. Meganephric.

Reproductive system. Testes, two pairs, in segments 10 and 11, into which the rosettes open. The testes and rosettes on each side in each segment, enclosed by a membraneous bag filled with sperm.

Prostates tubular and coiled, in segments 18 and 19.

Sperm sacs, two pairs, one on the anterior wall of segment 12, the other on the posterior wall of segment 9.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, five pairs, in segments 5–9. Each consisting of a large sac and small diverticulum, not more than one-third the length of the former.

Habitat. Fern Tree Gully, under logs.

(15) *Perichæta alsophila*, sp. n. (Figs. 10, 11, 12). Length of spirit specimen $1\frac{1}{2}$–2 inches, breadth nearly $\frac{1}{8}$ inch. Number of segments about 104.

Prostomium not completely dovetailed into the peristomium (about half). The peristomium marked by a median ventral furrow.

Clitellum well marked, complete, occupying segments 14, 15, 16.

Setæ, in front of the clitellum, 10–11 each side; behind the clitellum, 13 each side. The rows regular.

Male pores on two fairly well marked papillæ on segment 18, at the level of the interval between the second and third setæ of each side.

Oviduct pores on segment 14 slightly anterior to, and ventral of, the level of the setæ.

Spermathecal pores, four pairs, between segments 5 and 6, 6 and 7, 7 and 8, 8 and 9, at the level of the innermost setæ of each side.

Accessory copulatory structures. Two ridges with swollen ends, one immediately in front of, the other immediately behind, the male openings. Both have their swollen ends at the level of the interval between the two inner setæ of each side. One is placed half on each of the segments 17 and 18, the other half on each of the segments 18 and 19. A smaller ridge with two confluent swellings, half on each of segments 16 and 17, and situated in the mid-ventral space between the innermost rows of setæ. Two elliptical tumid patches in the mid-ventral space, one on the posterior half of segment 7, the other on the posterior half of segment 8.

Dorsal pores present, the first between segments 4 and 5.

Nephridiopores very prominent, at the level of the seventh seta of each side, and placed at the anterior margin of each segment, commencing with the third. On contraction in spirit, the body wall in transverse section has the form of an upper and lower half, meeting on each side at an angle which corresponds in position to the nephridiopore.

Alimentary canal. Gizzard in segment 5. No true calciferous glands, but large vascular swellings in segments 14 and 15, and smaller ones in segments 9–13. Large intestine commencing in segment 17.

Circulatory system. Dorsal vessel single. Last heart in segment 12.

Excretory system. Meganephric.

Reproductive system. Two pairs of testes in segments 10 and 11, into which open the rosettes.

Prostates tubular, coiled, in segment 18.

Sperm sacs, two pairs, one attached to the anterior wall of segment 12, the other to the posterior wall of segment 9. Sac-like in form.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, four pairs, in segments 6–9. Each consisting of a large sac and short somewhat thin diverticulum.

Habitat. Fern Tree Gully, under logs.

(16) *Perichæta fielderi*, sp. n. (Figs. 19, 20, 21, 64). Length in spirits nearly 6 inches, breadth ¼ inch.

Both when alive and when in spirits, the worm has not the slightest resemblance in appearance to an ordinary perichæte form. It is only provisionally referred to this genus. The body is cream coloured, with a thick bright pink coloured clitellum, and is quite smooth, there being no indication of setæ, except in the clitellar region and perhaps an odd one here and there posteriorly; to see the setæ, it is necessary to cut sections. Its general appearance is closely similar to that of a Megascolides, to which genus I took it to belong when collecting it.

Prostomium possibly completely dovetailed into the peristomium, but the latter is strongly ribbed, two grooves being continuous with the edges of the prostomium, which has also a median furrow continued on to the peristomium.

Setæ, about six on each side, irregularly arranged behind the clitellum. In segments 13–16, a pair can often be seen on either side ventrally.

Clitellum well marked and thick, extending over segments 13–18; complete, save for two small depressed patches ventrally, one in the middle of segment 16, another occupying the hinder part of segment 17 ventrally, and the anterior of 18. These depressed patches may be absent, and the clitellum complete, in some specimens.

Male pores on two prominent papillæ, which may have their inner sides confluent, on segment 18. The pores at the level of the interval between the two inner setæ of each side.

Oviduct pores in a small linear depression on the anterior half of segment 14, each pore slightly ventral of the level of the innermost setæ.

Spermathecal pores, two pairs, one on the posterior margin of segment 7, another on the posterior margin of segment 8. Each pore is placed on a small, tumid, elliptical patch.

Accessory copulatory structures. An elliptical patch ventrally, half on each of segments 19 and 20, a similar one half on each of segments 20 and 21. Only one of these may be present.

Dorsal pores present.

Alimentary canal. Gizzard in segment 15. Vascular swellings in segments 11 and 12. Calciferous glands somewhat ventrally placed in segment 13. Large intestine commencing in segment 17. Prominent glandular tufts (pepto-nephridia ?) attached to the pharynx.

Circulatory system. Dorsal vessel single. Hearts in segments 8–13. A continuous supra-intestinal vessel in segments 9–14. A lateral vessel in segments 7–13.

Excretory system. Plectonephric.

Reproductive system. Testes not visible, but a large membranous sac on each side in segment 11 filled with sperm, and enclosing a prominent rosette. Probably this encloses also the testes.

Prostates flattened, rather small; mammillated surface; in segment 18. A large whitish swelling close to each duct, containing penial setæ.

Sperm sacs, one pair, attached to the anterior wall of segment 12.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, two pairs, in segments 8 and 9. Each consisting of a large sac and diverticulum.

Habitat. Narre Warren. Fern Tree Gully (collected by Rev. W. Fielder and Mr. Mann). Sassafras Gully (collected by Mr. Shephard). Under logs, in burrows partly exposed when the log is lifted, and partly penetrating to a depth of one or two feet beneath the surface.

The first specimens of this were found by the Rev. W. Fielder and Mr. Shephard, and subsequently Mr. French and myself found it abundantly at Narre Warren. Its area of distribution appears to be very limited, as I have never found it elsewhere, or received it from other districts.

(17) *Perichæta frosti,* sp. n. (Figs. 13, 14, 15, 71). Length of spirit specimen 6 inches, breadth about ¼ inch. Number of segments about 220.

As in the case of *P. fielderi,* the worm has not the slightest resemblance in appearance to an ordinary perichæte. It resembles closely in general appearance the group of forms at present classed together under the genus Cryptodrilus. In spirit the body is bleached, and the clitellum of a light brown colour.

Prostomium not at all dovetailed into the peristomium.

Setæ, save an odd one here and there, are invisible.

Clitellum strongly marked, saddle-shaped, incomplete ventrally, except in the middle of segments 16 and 17, extending over segments 14–17.

Male pores on very prominent papillæ on segment 18.

Oviduct pores placed on a ridge which runs across the anterior part of segment 14.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9.

Dorsal pores present, the first between segments 3 and 4.

Alimentary canal. Gizzard in segment 6. Calciferous glands in segments 8, 9 and 10. Vascular swellings in segments 11, 12 and 13. Large intestine commencing in segment 15.

Circulatory system. Dorsal vessel single, as far back as segment 13. In segment 14 and succeeding ones to the posterior end, it is double—that is, there is a loop in each segment, the two parts uniting at the septum. Hearts in segments 6-13. A lateral vessel is present on each side in segments 8, 9 and 10.

Excretory system. Plectonephric.

Reproductive system. A single pair of testes and rosettes in segment 11.

Prostates small, flattened; bi-lobed; in segment 18.

Sperm sacs. A pair attached to the anterior wall of segment 12, and a smaller pair to the anterior wall of segment 13. Sac-like in form.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, five pairs, in segments 5–9. Each consisting of a short sub-spherical sac, with a blunt rounded diverticulum about quarter the size of the sac.

Habitat. Croajingolong, E. Gippsland. Collected during an expedition of the Field Naturalists' Club of Victoria to Eastern Gippsland. I have associated with this the name of Mr. Frost, to whom I am indebted for much valuable aid.

(18) *Perichæta goonmurk*, sp. n. (Figs. 16, 17, 18). Length in spirits $4\frac{1}{2}$ inches, breadth $\frac{3}{16}$ of an inch. Number of segments about 150.

The body is dark purple colour dorsally. Laterally it is dark purple, but chequered with little rectangular cream coloured areas, in the centre of each of which is a seta.

Cream white on the ventral surface. The colour is much the same in spirit-preserved animals, as in the fresh state. This form is provisionally referred to the genus Perichæta.

Prostomium very slightly dovetailed into the peristomium.

Clitellum well marked, complete, light grey in colour, extending over segments 13–19.

Setæ. The first setigerous segment has 4 setæ on each side. The second 5, then up to the clitellum there are 6. The 20th and remaining segments have 8. The setæ are irregularly arranged, save the inner two of each side.

Male pores on papillæ on segment 18, each slightly ventral of the level of the second setæ of each side. There is a marked depression immediately in front of, and behind, a median ventral ridge on segment 18.

Oviduct pores on segment 14 anterior to, and very slightly ventral of, the level of the innermost setæ.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9. Each slightly ventral of the level of the innermost seta.

Dorsal pores.

Alimentary canal. Gizzard in segment 5. No true calciferous glands, but vascular swellings in segments 8–14, those in segments 13 and 14 smaller than the others. Large intestine commencing in segment 16.

Circulatory system. Dorsal vessel double as far forward as the sixth segment, where the two halves do not unite anteriorly, but pass forwards on to the surface of the gizzard. In each segment the two halves unite where they pass through the septum. In addition to the dorsal, there is a *double supra-intestinal* vessel in segments 9–12. Hearts in segments 8–11. In segment 8, the hearts arise from the dorsal vessel. In segments 9–11, they arise from the supra-intestinal.

Excretory system. Plectonephric, associated with large nephridia with internal funnels at the posterior end of the body.

Reproductive system. Two pairs of testes in segments 10 and 11. Rosettes doubtful.

Prostates flattened, somewhat fan-shaped structures in segment 18.

Sperm sacs, a single small pair attached to the anterior wall of segment 12. Sac-like in form.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, five pairs, in segments 5–9, gradually increasing in size from before backwards. Each consisting of a sac, with a short blunt rounded diverticulum.

Habitat. Mt. Goonmurk, Croajingolong. Whilst collecting in Croajingolong I only found this interesting form, the colouring of which renders it at once noticeable, under logs at the head of a fern gully on Mt. Goonmurk, at an elevation of about 3500 feet. Mt. Goonmurk forms part of the Dividing Range which runs from east to west across Victoria.

(19) *Perichæta yarraensis*, sp. n. (Figs. 61, 62, 63, 74). Length of spirit specimen 5½ inches, of living form 7 or 8 inches, breadth ½ inch.

In life the body is of a dull purple colour, darker dorsally than ventrally. The setæ are placed on little lighter-coloured spots. The clitellum stands out very clearly in the living form, being thick and cream white in colour.

Prostomium completely dovetailed into the peristomium.

Clitellum thick and strongly-marked, and extending over segments 13–17. The ventral surface of segments 15, 16 and 17 is not always white and glandular, the clitellum here being then incomplete and saddle-shaped. In other specimens it is complete.

Setæ. The first two setigerous segments have four on each side, arranged in two couples. Back to the clitellum there are two couples on each side, and in addition a fifth one external to these. Occasionally, but rarely, an additional one may be developed, but the worm can be recognised by the presence of five setæ on each side, regularly arranged so far back as the clitellum and including, at any rate, the two first segments of this. Worms from four localities all show this feature. Behind the clitellum the number increases to 10–14 on each side, arranged, save the innermost one, very irregularly. There is left a broad very irregular dorsal space free from setæ.

Male pores on slight papillæ, from which penial setæ may be seen protruding, on segment 18, at the level of the interval between the two inner setæ of each side.

Oviduct pores on segment 14 anterior to, and ventral of, the level of the innermost setæ.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9, at the level of the innermost setæ.

Accessory copulatory structures. Three pairs of elliptical tumid patches in front of the male openings, and three or four behind. One pair placed half on segment 17, and half on segment 18, at the level of the interval between the second and third seta on each side. The others placed at the level of the interval between the two inner setæ of each side, and placed respectively half on each of the following segments, 15 and 16, 16 and 17, 19 and 20, 20 and 21, 21 and 22, 22 and 23. Each is marked by a median linear depression.

Dorsal pores present, the first between segments 5 and 6.

Alimentary canal. Gizzard in segment 5. No true calciferous glands present, but vascular swellings in segments 13, 14 and 15. Large intestine in segment 17.

Circulatory system. Dorsal vessel single. A supra-intestinal vessel present in segments 10–13. The last heart in segment 12.

Excretory system. Meganephric.

Reproductive system. Two pairs of testes in segments 10 and 11, into which the rosettes open. These segments are filled with masses of sperm, but these are not enclosed in sacs.

Prostates coiled, tubular, occupying segments 18, 19 and 20.

Sperm sacs, three pairs. Two large ones attached to the anterior walls of segments 12 and 13, a smaller pair attached to the posterior wall of segment 9. Sac-like in form.

Ovaries in segment 13, into which the oviducts open.

Spermathecæ, five pairs, in segments 5-9. Each consisting of a long sac, with a short diverticulum about one-fifth the length of the former.

Habitat. Tanjil Track, near Wood's Point. Warragul. Warburton.

(20) *Perichæta tanjilensis.* Length of spirit specimen 3½ inches, breadth ⅜ inch. The worm contracts very much in spirits. When alive, it has a dull grey purple colour.

Prostomium completely dovetailed into the peristomium, and marked by a median groove continuous with one which runs along the mid-dorsal line of the body.

Clitellum not strongly marked, occupying segments 14–17, and slightly darker than the surrounding parts.

Setæ. The number and arrangement varies slightly, but the following description of a particular specimen may be taken as fairly representative:—The first six setigerous segments have four on each side, arranged in couples. The seventh has four on one side and five on the other. The eighth, four on each side; and the ninth, four on one side and six on the other. The tenth, six on each side. The eleventh, four on one side and six on the other. The twelfth, four on one side and seven on the other. The thirteenth, five on each side. The fourteenth, six on each side. The fifteenth and sixteenth, five on one side and six on the other. The seventeenth, six on each side. The eighteenth, nineteenth, twentieth, twenty-first, and twenty-second segments have eight on each side, except on the right of the twentieth, where there are six. Behind this, the number varies from 6–10 on each side. The two inner rows on each side are regularly arranged, except during the posterior third of the body. The dorsal interval free from setæ is broad and irregular.

Male pores not on papillæ, at the level of the interval between the two inner setæ of each side, on segment 18.

Oviduct pores on segment 14 anterior to, and slightly ventral of, the level of the innermost setæ.

Spermathecal pores, five pairs, between segments 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9, at the level of the innermost setæ.

Accessory copulatory structures. The whole of the ventral surface of segments 16–21 is deeply depressed in spirit specimens. Four pairs of small elliptical tumid patches are present, each at the level of the second seta. The first are placed half on segment 16, half on segment 17, and the remaining three respectively, half on segments 17 and 18, 19 and 20, 20 and 21.

Dorsal pores present, the first between segments 4 and 5.

Alimentary canal, Circulatory system, Excretory system and Reproductive organs similar to those of *P. yarraensis*.

This form is closely allied to the latter, but the presence in *P. yarraensis* of 5 setæ regularly arranged on each side in front of the clitellum, renders it distinct and easy to recognise.

Habitat. Gembrook (Mr. D. le Souëf), Warburton, Tanjil Track (near Wood's Point), Fern Tree Gully, and Dandenong.

(21) *Perichæta bakeri** (Fletcher). (Figs. 22, 23, 24, 75).

This form was first obtained by Mr. Fletcher from Warragul. It is very abundant there under logs, and is a characteristic Gippsland form. I have since collected it in abundance at Warragul, and the surrounding district, Fern Tree Gully and Narre Warren, and have received it from Gembrook (Mr. D. le Souëf), and Healesville (Dr. Dendy).

(22) *Perichæta dorsalis*† (Fletcher). (Figs. 58, 59, 60).

This form was first obtained by Mr. Fletcher from Warragul. It is present in a much greater proportion than any other single species, and has come to me from very many parts of the colony. We did not however secure it in Croajingolong, and it does not appear to extend into the east and north-east parts of the colony.

Specimens have been secured at Warragul, Fern Tree Gully, Gembrook (Mr. D. le Souëf), Narre Warren, Dandenong, Creswick (Mr. J. Fiddian), Castlemaine (Mr. T. S. Hall), Myrniong (Mr. C. Brittlebank), Grampians (Mr. C. Frost), Gerangamete (Mr. R. L. Anderson), and Walhalla (Mr. H. R. Hogg).

DESCRIPTION OF PLATES II, III, IV, V, VI & VII.

In the case of each species one drawing represents the external anatomy, a second the alimentary canal, circulatory system and disposition of nephridia, and a third the reproductive system. On Plate VII the spermathecæ are drawn in outline (under the camera lucida × 4). Lines represent the position of the two inner rows of setæ on each side.

Reference Letters.

Acc.	Accessory copulatory structures.	*Ovd.*	Oviduct.
Calc.	Calciferous glands.	*Pr.*	Prostate gland.
Clt.	Clitellum.	*R.*	Sperm rosette.
D.Bv.	Dorsal blood-vessel.	*Spth.*	Spermathecæ.
Gz.	Gizzard.	*T.*	Testis.
Hts.	Hearts.	*Vasc.*	Vascular swellings on œsophagus.
L.	Intestine.	*V.S.*	Sperm sacs.
Ov.	Ovary.		

* Proc. Linn. Soc., N.S.W., Vol. II (Series 2nd), September 28, 1887, p. 616.

† Proc. Linn. Soc., N.S.W., Vol. II (Series 2nd), September 28, 1887, p. 618.

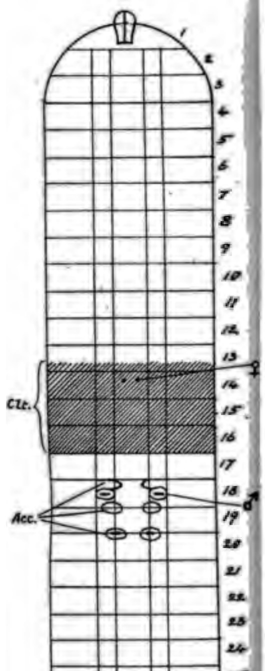


Fig 1.

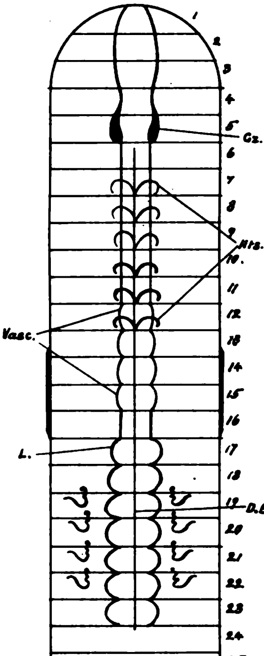


Fig 5.

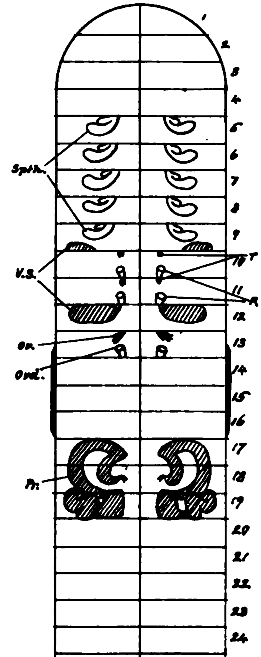


Fig 6.

PERICHÆTA OBSCURA.

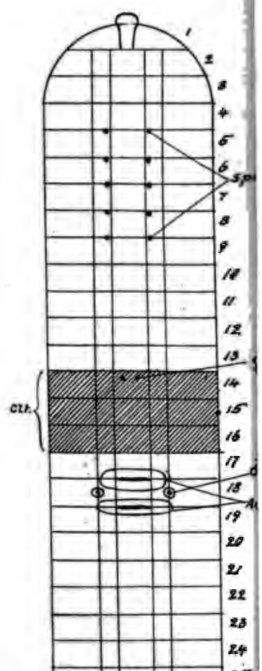


Fig 7.

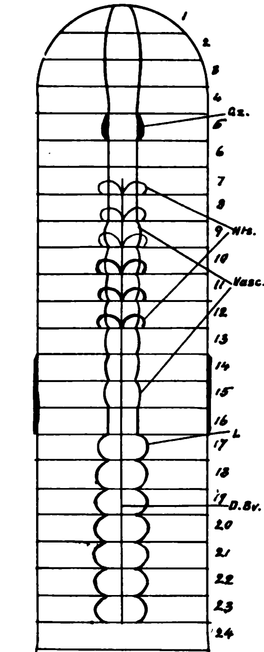


Fig 11.

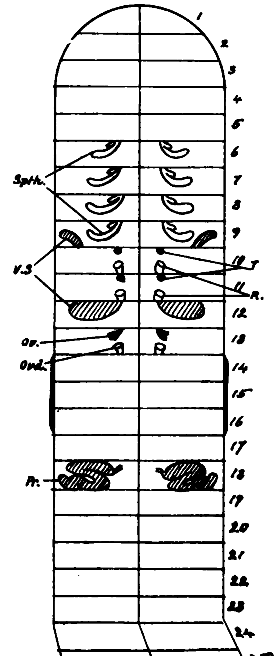


Fig 12.

PERICHÆTA ALSOPHILA.

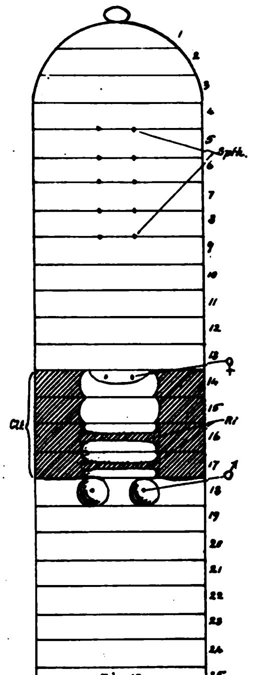


Fig 13

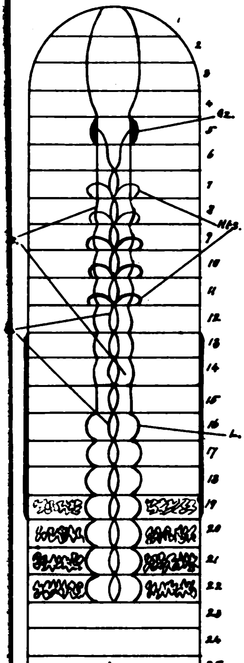


Fig 17

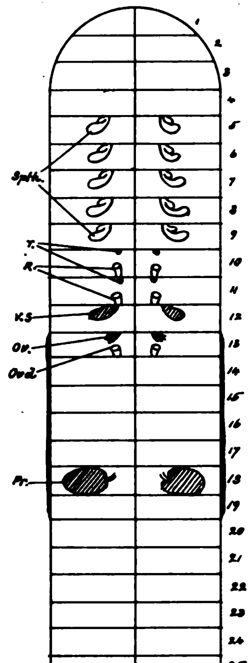


Fig 18.

PERICHÆTA COONMURK.

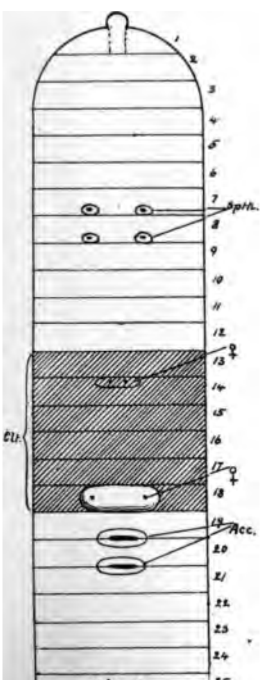


Fig 19.

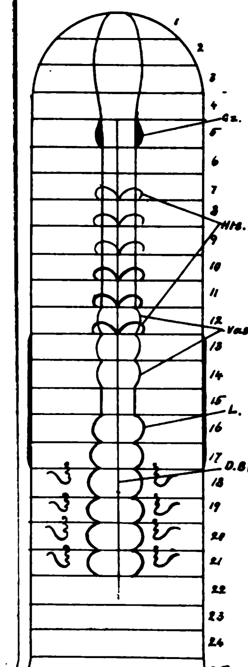


Fig 23.

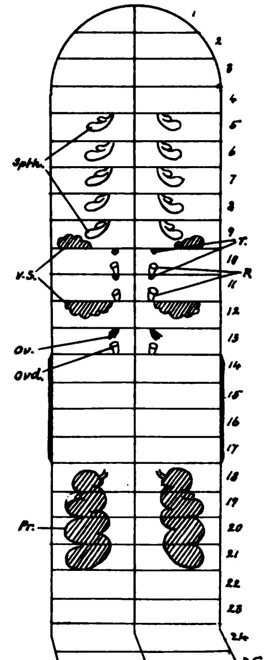
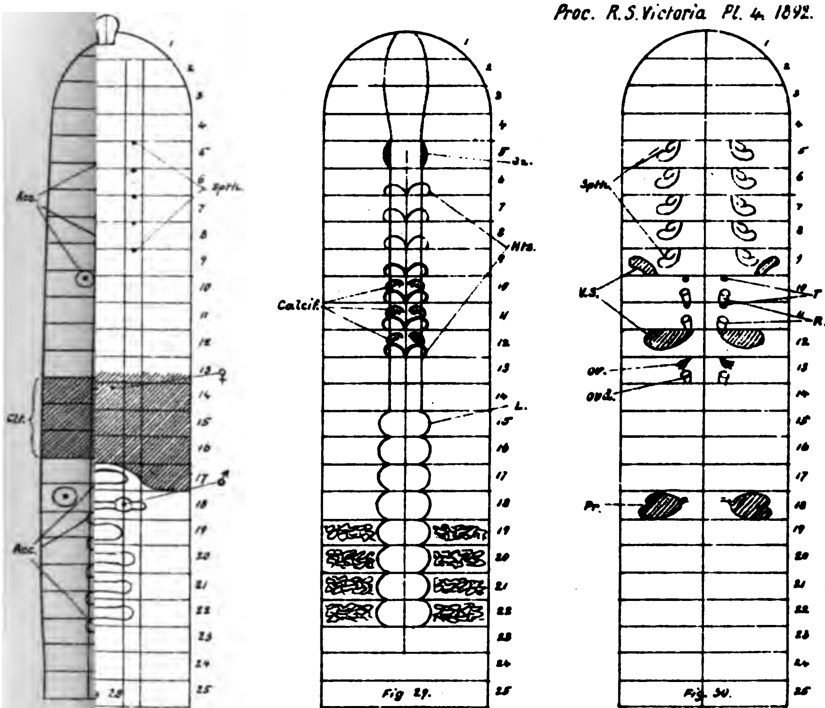
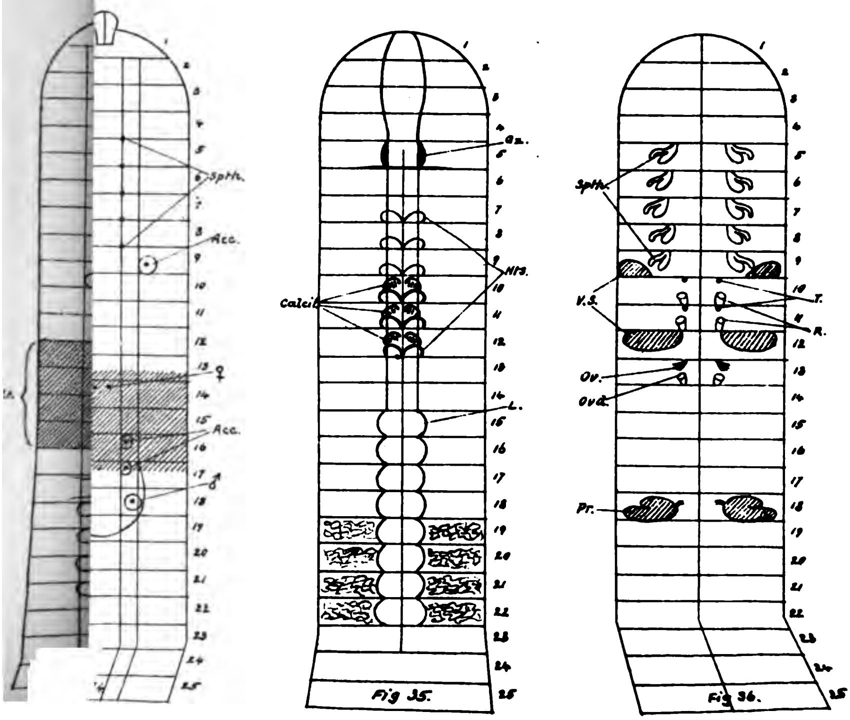


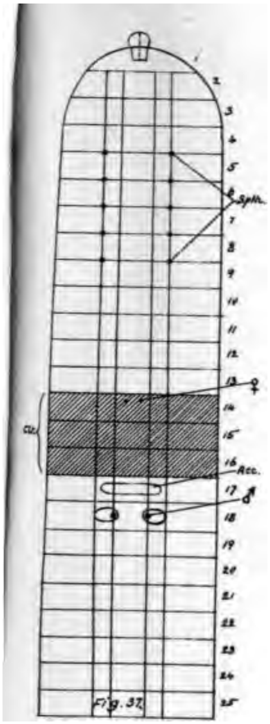
Fig 24.

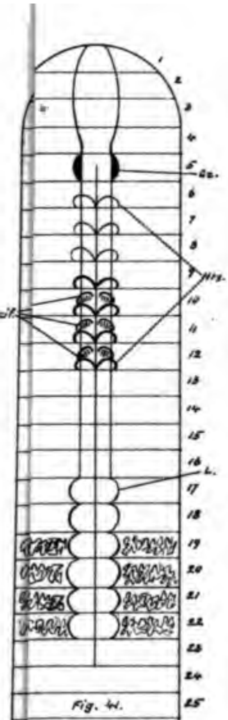
ERICHÆTA BAKERI.

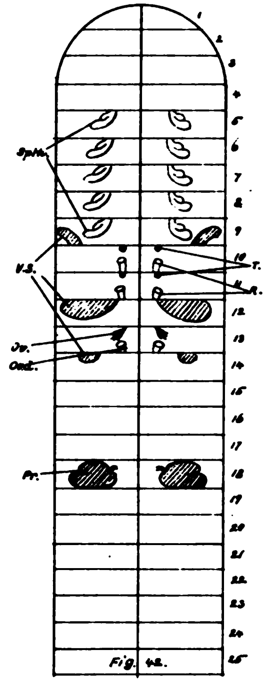


PERICHÆTA HOGGII.









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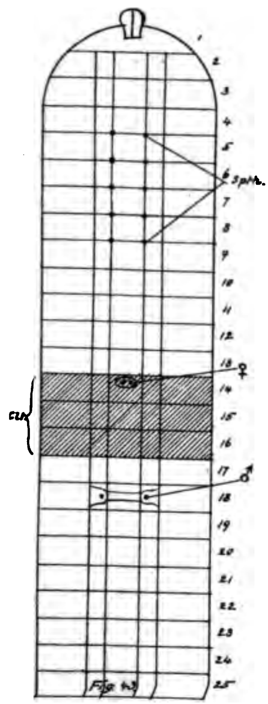
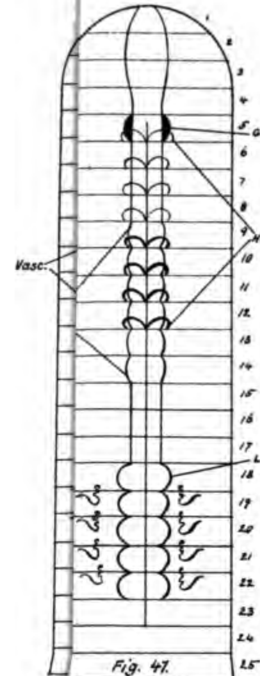
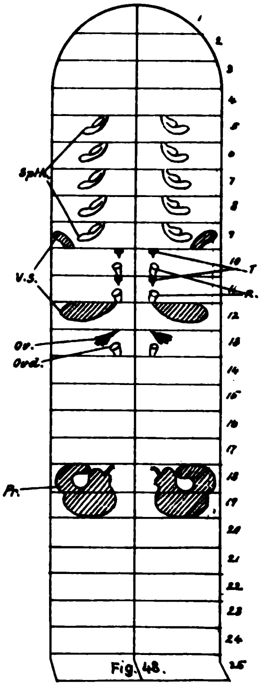
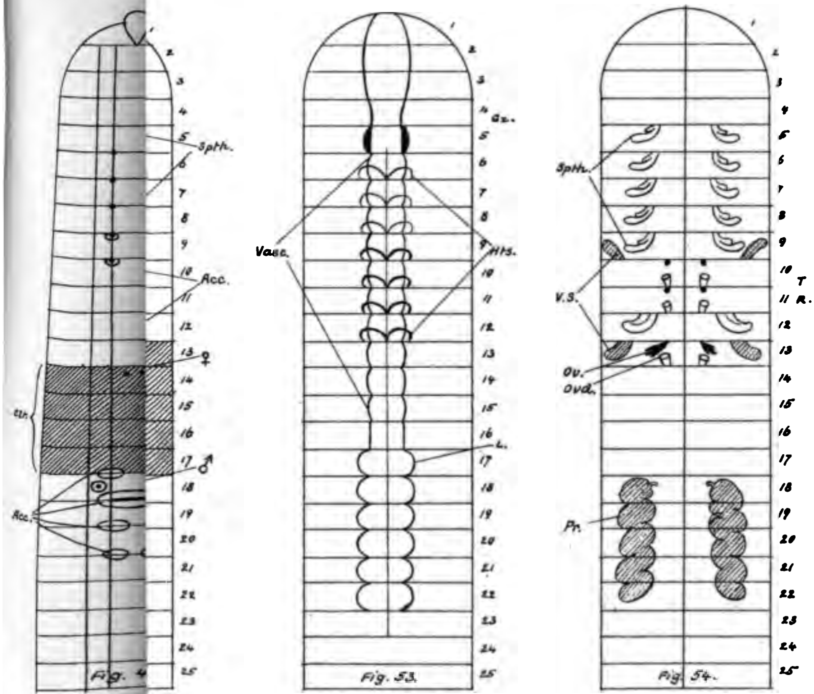


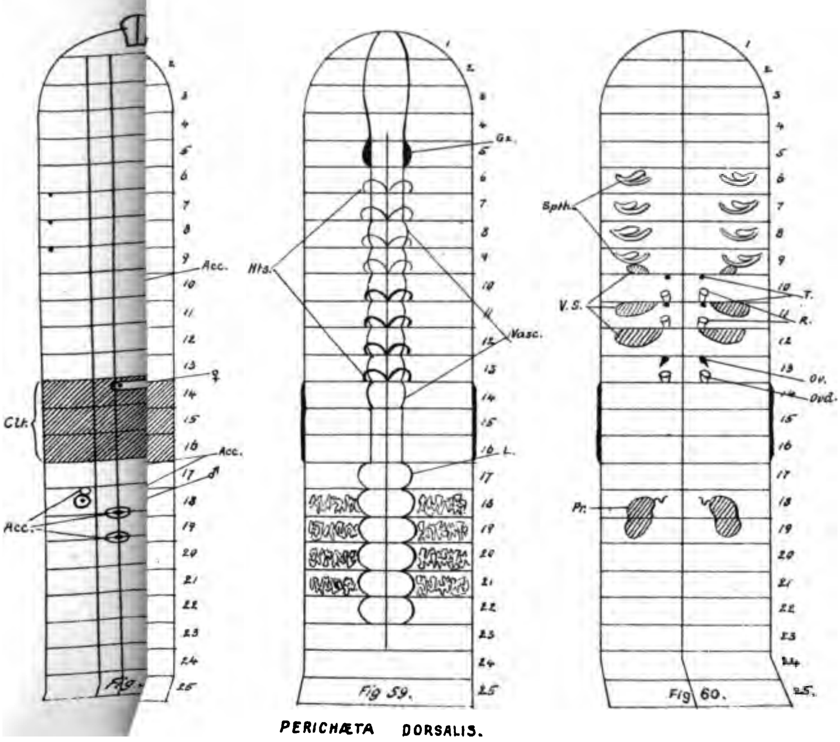




PERICHÆTA

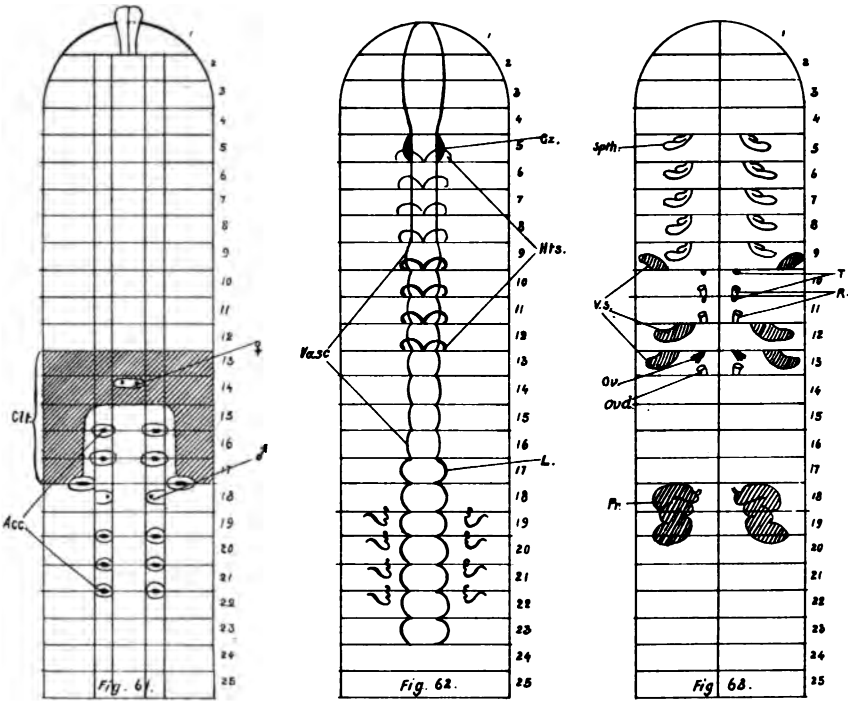


PERICHÆTA COPELANDI.



PERICHÆTA DORSALIS.

[redacted]



PERICHÆTA YARRAENSIS.

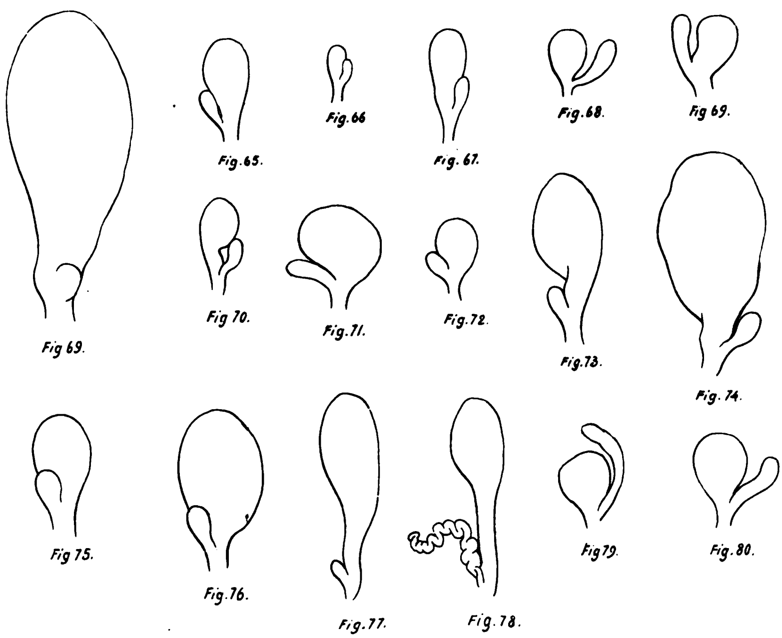


Fig 69. Fig. 65. Fig. 66 Fig. 67. Fig. 68. Fig 69. Fig 70. Fig. 71. Fig. 72. Fig. 73. Fig. 74. Fig 75. Fig. 76. Fig. 77. Fig. 78. Fig 79. Fig. 80.

ART. II.—*Further Notes on the Oviparity of the larger Victorian Peripatus, generally known as P. leuckartii.*

By ARTHUR DENDY, D.Sc.

[Read May 12, 1892.]

My observations* on the oviparous habit of the larger Victorian *Peripatus* (hitherto generally regarded as identical with the *Peripatus leuckartii* of Sänger) have excited a good deal of hostile criticism, chiefly emanating from the pen of Mr. J. J. Fletcher. On three different occasions since the publication of my notes Mr. Fletcher has brought the question before the Linnean Society of New South Wales and his remarks have been published (I do not know whether in full or not) in the Abstracts of Proceedings of the Society.†

I have already replied to the earlier criticisms in a short paper read at the Hobart meeting of the Australasian Association for the Advancement of Science, which will, I am informed, be published shortly. Mr. Fletcher's latest observations, however, compel me to return to the question and I am the more willing to do so as I have some further information to communicate in support of my views.

The object of Mr. Fletcher's latest contribution to the literature of the subject is explained in the opening paragraph, which runs as follows:—"This paper is a reply to certain views expressed by Dr. Dendy with regard to the reproduction of the New South Wales *Peripatus*, which on the *ipse dixit* of Dr. Dendy himself is *P. leuckartii*, Säng.; the questions at issue being not whether or no the Victorian *Peripatus* is oviparous, but whether, firstly, Dr. Dendy was

* Proc. Royal Soc. Victoria for 1891, p. 31; *Nature* and *Zoologischer Anzeiger*, No. 380, 1891.

† September 30, 1891; February 24, 1892; April 27, 1892.

justified, on the evidence before him and in the absence of any personal knowledge of the reproduction of the New South Wales *Peripatus*, in contradicting statements which were quite in order; and secondly, as Dr. Dendy's views were published in September 1891, and as certain information on the subject was subsequently brought under his notice, whether it is not now nearly time that Dr. Dendy took steps to explain that his views apply wholly and solely to the Victorian *Peripatus*, and to withdraw his insinuations respecting, and his erroneous interpretation of, 'Mr. Fletcher's observations,' because already Dr. Dendy's statements are finding their way into the records of zoological literature, and confusion and misapprehension may result therefrom."

In reply to Mr. Fletcher's indictment I wish to make the following remarks:—

(1) I do not understand the meaning of the statement that the New South Wales *Peripatus* is, "on the *ipse dixit* of Dr. Dendy himself," *P. leuckartii*. I certainly am not responsible for this identification, which was, I believe, first made by Mr. Olliff, who remarks,* on first recording the animal from New South Wales, that "the species is identical with that recently recorded by Mr. Fletcher from Gippsland and is probably the *Peripatus leuckartii* of Sänger." I need scarcely point out that the name *leuckartii* has since been applied by Mr. Fletcher himself to the New South Wales species.

Possibly Mr. Fletcher means to refer to the larger Victorian species, of which the first recorded specimen was identified by *himself* † as "in all probability an example of *P. leuckartii*, Sänger." If Mr. Fletcher will refer to my earliest communication on the subject‡ he will find that in recording the discovery of two specimens at Warburton (only one specimen having been previously recorded from this colony) I made the following statement, "after carefully studying Professor Sedgwick's full description of *P. leuckartii*, I am fairly certain that they do not belong to that species, but to a new one, which I for the present refrain from naming," basing my conclusion on the remarkable pattern of the skin.

* Proc. Linn. Soc. N.S.W., Vol. II, p. 981.

† Proc. Linn. Soc. N.S.W., Vol. II, p. 450.

‡ *Victorian Naturalist*, January 1889.

Professor Sedgwick, however, in reply to my observations, expressed the opinion* that the species probably was subject to a considerable range of variation in colour. Having studied more specimens I myself came to the same conclusion† and have since then *followed* Mr. Fletcher in calling the larger Victorian species *P. leuckartii.* This use of the name *leuckartii* on my part seems to be Mr. Fletcher's chief grievance against me but I would ask him to remember that I have only followed his own lead in this respect.

(2) I am not aware that I have contradicted any statements for the simple reason that I cannot find that there were any definite statements as to the mode of reproduction of the New South Wales *Peripatus* for me to contradict. There was merely the assumption by Mr. Fletcher (which I quoted and characterized as very natural) that the young animals which he found in company with the parent had been born alive.

(3) I consider that I was fully justified in assuming that the mode of reproduction of the New South Wales *Peripatus* was the same as that of the Victorian one, as at the time when I wrote there were no definite observations published as to the mode of reproduction of the former, and it was almost inconceivable that different individuals which Mr. Fletcher himself, in common with all other writers on the subject, regarded as belonging to one and the same species should be oviparous in the one colony and viviparous in the other. I have no doubt now that the New South Wales *Peripatus* is viviparous, as maintained by Mr. Fletcher and Professor Haswell, but I would ask Mr. Fletcher to remember that when I wrote, the only published observations as to the mode of reproduction of the New South Wales species were—(*a*) the finding of the young in company with the mother, though there was nothing, so far as the published account goes, to show that they had not been hatched from eggs laid for some time; and (*b*) a footnote‡ to one of Mr. Fletcher's observations, stating that a female had been dissected and found to be pregnant; the term pregnant is not defined and might, in my opinion, be

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* *Nature*, February 28, 1889.

† "Observations on the Australian Species of Peripatus," Proc. Royal Soc. Victoria, July 11, 1889.

‡ Proc. Linn. Soc. N.S.W., Vol. III, p. 892.

correctly applied to a female containing large but undeveloped eggs in the uterus; nothing is said by Mr. Fletcher about the embryos.

Mr. Fletcher may personally have had abundant evidence that the New South Wales *Peripatus* was viviparous, but that evidence was not published and not known to me when I wrote, and, therefore, I consider that I was quite justified in stating that the mode of reproduction of *P. leuckartii* was unknown, and in placing my own interpretation upon the only recorded facts as to the life history of the New South Wales form. Naturally I interpretated them in the light of my own observations on the Victorian species. That interpretation I now fully admit to be incorrect and I congratulate myself that if my observations have had no other good result they have at least elicited some definite information as to the mode of reproduction of the New South Wales *Peripatus.*

(4) Mr. Fletcher seems to be very greatly troubled because my statements are already "finding their way into the records of zoological literature, and confusion and misapprehension may result therefrom." There is not the slightest need for confusion now that we have at length a definite statement as to the reproduction of the New South Wales species. It must be perfectly obvious to every reader that my own observations were based entirely on Victorian specimens, as stated distinctly in the paper, and that my suggestion as to the New South Wales form was a perfectly justifiable, though, as it turns out, incorrect deduction from the only published facts. It is perhaps unfortunate that both the New South Wales and Victorian forms should have been included under the name *leuckartii*, but for this Mr. Fletcher himself is at least as much responsible as any one.

(5) Mr. Fletcher states that the question at issue is not whether or no the Victorian species is oviparous. Herein I must beg to differ from him, as this is the real question which I have been all along trying to solve and compared with which the mere question of nomenclature is, in my opinion, insignificant In concluding his observations he also indulges in certain offensive and unjustifiable personalities, which I need not quote. It is greatly to be regretted that he should have considered such a proceeding advisable

and, for my own part, I entirely fail to see the advantage to be derived therefrom and must refuse to follow his example in this respect.

Probably the solution of the whole difficulty will be found to lie in the fact that my original opinion was correct after all, and that our larger Victorian *Peripatus* is specifically distinct from *P. leuckartii.* For the present, however, I still refrain from giving it a distinctive name, as I have had very few specimens from other localities to compare it with and do not wish, if it can be helped, to create a new species merely on account of the oviparous habit. This question, however, is discussed in my communication to the Australasian Association already referred to.

As to the oviparous habit of our larger Victorian species (so called to distinguish it from the smaller *P. insignis*), I have some additional evidence to offer and I would like at the same time to recapitulate the main arguments in favour of my view. My critics have entirely ignored all that is new in my observations, such as the remarkable sculptured egg-shell, and have suggested that what I have observed is simply a case of abnormal extrusion of eggs such as takes place sometimes in *P. novæ-zealandiæ.* Professor Hutton, however, who made the observation on the New Zealand species, merely states that the eggs are often extruded before development is complete and then always die. Professor Sedgwick quotes these statements in his monograph of the genus and yet, in replying* to my letter in *Nature,* he states that "no one knows whether the eggs so extruded undergo complete development." I suppose that most animals sometimes extrude eggs which never complete their development, but this has really little to do with the question. What I have been endeavouring to prove is that the larger Victorian species of *Peripatus* is *normally* oviparous. The two principal arguments originally brought forward—both of which have been entirely overlooked by my critics—were (1) that female specimens dissected at various times of the year were never found with embryos in the uterus, as has been so frequently described for other species, but generally with large undeveloped eggs of definite oval shape and with a thick membrane; (2) that the shell or membrane of the eggs after (but not before) being laid, is very definitely and characteristically sculptured on the outer surface, in such

* *Nature*, September 24, 1891.

a manner as to recall the eggs of some insects. This sculpturing alone appears to me to indicate a truly oviparous habit, and, inasmuch as it affords another character common to *Peripatus* and the *Insecta,* to deserve special attention. I am not aware that a sculptured egg-shell has hitherto been observed in *Peripatus* and I should be glad to learn from Mr. Fletcher whether anything of the kind has ever been found around embryos of the New South Wales species which have, as he informs us,* been extruded in the process of drowning.

The additional evidence on the subject which I now wish to bring forward consists in the subsequent history of the fourteen eggs which were laid in my vivarium between the 18th May and the 31st July last year and of one which, though possibly laid about the same time, was not discovered until September 16. Before going any further, however, I may premise that the fact that the eggs are really those of *Peripatus* has been absolutely proved by their development. It may also be as well to relate the fate of the parent animals by which the eggs were laid.

It may be remembered that on the 31st July, 1891, when the eggs were first found, there were in the vivarium three females and one male, all apparently in good health. The male specimen died shortly afterwards but on August 17th the females were still all alive and apparently healthy. On August 31st, as mentioned in a postcript to my first communication on the subject, one of the female specimens was found dead. On being dissected the reproductive organs appeared very well developed; but, although the ovary and oviducts were both large (the former containing a great many ovarian eggs), there was not a single egg in either of the oviducts, all having been doubtless laid.

On September 16th the two remaining females were still alive. I killed and dissected one. The organs appeared healthy and well developed. In the lower part of each oviduct one large egg was found. The eggs presented the usual characters, having a very thick but unsculptured envelope filled with yolk. Both eggs were cut open and examined microscopically, but I did not succeed in recognising any trace of an embryo in either.

On completely turning out the vivarium and examining its contents carefully, I found one more *Peripatus* egg

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* Proc. Linn. Soc. N.S.W., September 30, 1891.

amongst the rotten wood (September 16). It looked much healthier than those which had previously been transferred from the vivarium, many of the latter having already begun to shrivel up and acquire a dark colour. In the newly found egg and also in the healthier-looking of those previously obtained there now appeared to be a dark spot in the interior, but this was only dimly visible through the thick sculptured shell.

On September 25th the last remaining female was still apparently in good health but on October 1st it was found dead—how long it had been so I do not know. On dissection I found the internal organs in a bad condition. Neither eggs nor embryos were visible in the oviducts. The ducts of the slime glands were very much enlarged and swollen out, while the branching portions appeared feebly developed, in fact not distinctly recognisable. The alimentary canal was almost empty and the animal seemed to have died of starvation.

On October 3 I dissected one of the eggs from the hatching box. I could find no embryo in it but only the same semi-liquid, yolk-like contents as when *in utero*, full of little oil or yolk globules. Inside the thick, sculptured "shell" there was, as usual, a very thin and delicate, transparent membrane. Probably a young embryo was really present but was broken up in opening the egg and overlooked; even at a much later period the embryonic tissues are extremely delicate.

On November 30 I noted that several of the eggs were shewing indications of an embryo appearing coiled up within them, but the shell was so thick and opaque that it was impossible to make out any details. I dissected the egg which was found on September 16 and which had since then been kept separate from the rest. I found in it a beautiful embryo *Peripatus* in an advanced stage of development. The embryo was surrounded by a delicate, transparent membrane, which fitted closely on to it and was very difficult to remove; outside this came the sculptured shell. The embryo possessed a distinct head, with clearly recognizable brain, eyes and ringed antennæ, and there were at least seven pairs of appendages behind the antennæ. It lay tightly coiled up, with the posterior extremity resting against the side of the neck, in such a position as to make it very difficult to count the appendages. The specimen was stained and mounted in Canada balsam. This embryo, then,

developed for more than ten weeks after the egg had been laid and did not show the least sign of "going to the bad."

I need hardly say that during the heat of the summer months I found it a very difficult matter to keep the eggs in a suitable condition of moisture, especially as I had no previous experience to guide me. Hence it is not to be wondered at that the majority of the eggs perished, shrivelling up and being attacked by a mould. As I was away from Melbourne for some weeks during the summer I entrusted the eggs to the care of the Rev. W. Fielder, who most kindly looked after them for me in my absence. Frequent attention was necessary in renewing the supply of moisture.

On April 14, 1892, only three eggs remained in the hatching box, the others having been removed as they showed signs of going bad. One of the remaining three had been showing dark pigment inside for some days past. This egg I removed and carefully dissected. I found the shell of a much darker (yellow) colour than when laid, a good deal crumpled on the surface, and very soft, as though beginning to decay away. The contained embryo was removed and found to be in excellent condition, although *outside* it there appeared under the microscope a great many very fine threads, which I take to be the hyphæ of a fungus. Possibly this fungus might have ultimately killed the embryo but the latter was so far advanced that it seemed to be on the verge of hatching. It was enclosed within the usual transparent delicate membrane lying within the thick shell. I could not determine whether the fungal hyphæ had penetrated within this inner membrane but I think it very doubtful. The embryo was tightly coiled up as in the previous case. When uncoiled it measured about 5 mm. in length (exclusive of the antennæ) and 1 mm. in breadth. *All* the appendages were developed, viz., antennæ, oral papillæ, two pairs of jaws and fifteen pairs of claw-bearing legs. The eyes were conspicuous at the bases of the antennæ, and the antennæ themselves showed each about twenty deeply pigmented annuli. The remainder of the body was nearly white, but very distinct, isolated pigment patches (chiefly indigo blue, with a few specks of orange) appeared scattered pretty abundantly over the legs and back. The mouth was surrounded by the very characteristic, thick, transversely furrowed lip. The dermal papillæ were very obvious and exhibited the characteristic spines, the cuticle being very strongly developed. The claws on the feet were very distinct. The alimentary canal

was full of granular food yolk. The specimen was stained with borax carmine and mounted in Canada balsam.

This embryo, then, developed for at least eight months and a half after the egg was laid and at the end of that time was a perfect young *Peripatus*, differing externally from the adult only in its smaller size and less deeply pigmented skin.

There are still two eggs left in the hatching box but they do not look to me at present as if they were going to hatch. Whether they do so or not, however, I think I may fairly claim to have now definitely proved that the larger Victorian *Peripatus* at any rate sometimes lays eggs, and that these eggs are capable of undergoing development outside the body until perfect young animals are produced. The great length of time required for the development of the eggs is very remarkable, but it is only what one might expect on considering the unusual length of time required for intra-uterine development in other species.

ART. III.—*Nest and Egg of Queen Victoria's Rifle Bird (Ptilorhis Victoriæ).*

(With Plate I.)

By D. LE SOUËF.

[Read March 9, 1892]

The nest and egg of the Victoria rifle bird here depicted, was taken on one of the Barnard Islands by Mr. H. Barnard and myself. We visited these islands on November 18, 1891, in quest of the egg of this bird, and built our small humpy about eight feet from a screw palm (Pandanus aquaticus), which grew just above high water mark. We saw a pair of rifle birds in some light scrub close by our camp, and they seemed very fearless, the hen bird especially so. Next morning was spent in searching over this interesting and densely timbered island, but without success. During the afternoon, however, we determined to watch the hen bird, which was seen on a tree close by, and so posted ourselves one on each side of the aforementioned patch of scrub. The bird had some moss in her bill, which she kept dropping and catching again before it reached the ground, and we naturally thought she was building, but presently she darted down into the scrub close by Mr. Barnard. In a few minutes he saw her fly into the screw palm by our camp, in which we found she had her nest. The nest itself which was built near the crown of the tree about seven feet from the ground, not being visible, and all we could see was the head of the bird. She continued sitting most of the next day, having apparently become accustomed to our presence.

We then took the nest and found it contained only one egg, which was hard set, the chick being about seven days old. The nest was built principally of vine tendrils and leaves rather loosely put together (Plate I).

Fig 1.

Fig 2.

R. Wendel del & lith. Troedel & Co.

The egg has a little more gloss on than is shown in the illustration.

Another egg and nest which was said to belong to this species was previously sent to Mr. C. French, in 1886, from the Cardwell Scrub, but the egg was spotted instead of being streaked, as in the present specimen; it is also smaller, and the nest, although made of somewhat similar material, is not so large, and is much more compactly built. Eggs of the same species of bird often vary considerably in colour, markings, and size, but still the general characteristics are the same, except in a few instances, notably the egg of the *Gymnorhina tibicen.* On several occasions I have noticed that the eggs laid by one pair of birds are almost identical with those laid by the same pair in the previous year, especially in the case of sea-birds, and it would be of interest to ascertain if this fact has been noted by other oologists.

ART. IV.—*Notes on the Lilydale Limestone.*

(With Plates VIII and IX.)

By REV. A. W. CRESSWELL, M.A.

[Read July 14, 1892.]

The limestone formation of Cave Hill quarry at Lilydale, the subject of this paper, is, for the most part, a hard semi-crystalline marble deposit, wedged in between hard quartzite on the one side, and soft shales and mudstones on the other; and has for many years past been recognised by Professor Sir F. M'Coy and others as of Upper Silurian age, of about the horizon of the English Wenlock, from an inspection of its contained fossils. The limestone strata dip to the east at varying angles of from 35° to 50°, the strike being nearly north and south magnetic, varying, however, on the east side of the quarry to as much as 18° east of magnetic north. The exact thickness of the limestone is not as yet known, for it does not naturally crop out on the surface, but is only artificially exposed by quarrying. As early as 1856, the late director of our Victorian Geological Survey, Mr., now Sir A. R. C. Selwyn, speaks* of the limestone as known to exist, but as only discoverable by a well-like hole on the side of the hill, leading into a cave hollowed out in the rock, and sloping down to a depth of 120 feet, with stalactites, &c. (a specimen of which is shown). But about fifteen years ago, a quarry was excavated in the limestone on the side of the hill, and the opening to the cave is now covered up with *débris*, and is inaccessible.

The progress of quarrying has now proved the limestone to be of much greater thickness than was at first reported.† The measurement across the outcrop is about 5 chains, or

* Report on Geological Structure of Colony of Victoria: Basin of Yarra, &c., 1856.

† "Victorian Naturalist," 1885, II, No. 3, p. 35.

330 feet, and allowing for the average dip of 40°, this would mean a vertical thickness of about 220 feet, but this is only so far as it is at present exposed. Its eastern limit may be considered to be about already reached, for almost immediately flanking it on that side may be seen an extensive series of quartzite and conglomerate strata, running conformably

CORRIGENDA ET ADDENDA.

Page 39. –For (See Fig. 1), read (See Fig. 9, Plate IXA).

For (See Fig. 2), read (See Fig. 10, Plate IXA).

,, 41.—Read "Pleurorhynchus costatus" and "Pleurorhynchus bellulus" under *Lamellibranchiata*, instead of under *Gasteropoda*.

Plate VIII.—1. Tremanotus pritchardi.

2. Eunema etheridgei.

3. Stomatia antiqua.

,, IX.—4. Tryblidium nycteis.

5. Pleurorhynchus costatus.

6. Pleurorhynchus bellulus.

7. Naticopsis lilydalensis.

8. Ambonychia tatei.

appears in the quarry, when looked at as a whole, and from a distance, is cream, or almost white, especially on weathered exposures; but when freshly broken, it is of different shades of dark or light bluish grey, pinkish brown, or grey with pinkish brown patches. It is for the most part semi-crystalline, is here and there somewhat brecciated on a small scale, and is in some places roughly oolitic (a slide of an oolitic specimen on view).

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330 feet, and allowing for the average dip of 40°, this would mean a vertical thickness of about 220 feet, but this is only so far as it is at present exposed. Its eastern limit may be considered to be about already reached, for almost immediately flanking it on that side may be seen an extensive series of quartzite and conglomerate strata, running conformably with the limestone; but on the west it is not yet defined, as it is still partly covered over with basaltic soil and decomposing basalt. (See Fig. 1.)

About half a mile off, or rather less, to the west, and on the other side of the valley, are a series of sandstones, shales, and mudstones exposed beneath the basalt in the Melbourne Road cutting, and seen to be dipping in the same direction as the limestone.

The lateral extension of this Lilydale limestone is a matter of much uncertainty. It is generally believed to be like most other Silurian limestones, and especially in Victoria, a mere lenticular or cake-like patch that rapidly thins out in all directions, but as the country in the neighbourhood is completely covered over with soil, trees, and verdure, it must remain more or less a matter of conjecture, until someone is enterprising enough to prospect the country, if not with a diamond drill, at least with a geological cheese-borer. Its *northern* extension has not been observed at all, but what looks somewhat like a *southern* extension of it may be seen in the shape of two bosses of the same kind of limestone in the side of the railway cutting, about three-quarters of a mile towards Melbourne, and somewhere about on the line of the strike of the limestone at Cave Hill quarry.

As it is hardly conceivable that the great thickness of the Cave Hill limestone, however lenticular it may be, can thin out so rapidly as all this, these two bosses, or boulders, in the railway cutting are probably mere outlying boulders of a southerly extension of the limestone that is mainly concealed beneath the surface. (See Fig. 2.)

The general colour of the Cave Hill limestone, as it appears in the quarry, when looked at as a whole, and from a distance, is cream, or almost white, especially on weathered exposures; but when freshly broken, it is of different shades of dark or light bluish grey, pinkish brown, or grey with pinkish brown patches. It is for the most part semi-crystalline, is here and there somewhat brecciated on a small scale, and is in some places roughly oolitic (a slide of an oolitic specimen on view).

The limestone strata are separated at intervals by five dark shaly or mudstone partings, averaging from 18 inches to 4 feet across; the thickest one, which is of a dark brown or claret colour, is upwards of 4 feet, and in this one is an almost perpendicular shaft-like cave, 91 feet deep, apparently caused by the action of running water.

I am informed by the owner, Mr. David Mitchell, of Burnley, that the limestone of his quarry has been long ago analysed, and runs to 95 or 96 per cent. of calcium carbonate. The limestone is in high esteem as the best and purest source of lime for building purposes in the colony. It has also been lately turned to profitable account in the manufacture of cement, and the owner informs me that the force required to pull it apart is 985 lbs. The stone has not been directly used for building purposes, but some slabs, which, when polished up, have an ornamental appearance, have been occasionally used for marble mantelpieces. Upon the whole, I think, therefore, we may congratulate Mr. David Mitchell upon having a more payable thing in his possession than many a gold mine. When the quarry has been in full work in prosperous times, he tells me that he has had as many as 120 men employed on it, and has been able to send away the almost incredible amount of 70 tons of lime a day. In these days of depression, however, when there is so little demand for lime, 20 men are found quite sufficient to do all the work of the quarry that is required.

The limestone of Cave Hill, like most other limestones, contains occasional patches of crystalline calcite, mostly in rhombohedrons or in modified scalenohedrons. It also contains segregated lumps and layers of chert, in which corals and other small fossils are sometimes beautifully preserved (specimens of both calcite and chert are exhibited). Associated with this same limestone, the following minerals have been found, but not in sufficient quantity to be of any commercial importance:—Galena, malachite, azurite, and copper and iron pyrites (specimens on the table). The great interest, however, of the Lilydale limestone lies in its fossils —of which, indeed, the limestone itself is largely composed—and which constantly attract scientific visitors from Melbourne and other places, and indeed from the neighbouring colonies.

In fact, one of my chief reasons in writing this paper is to take possession, in the name of Victorian geologists, of the priority in describing some of the fossils, as at present so many of them have been described by geologists outside the

colony; for without a moment wishing to do away with that principle of free-trade in scientific research that we all so much rejoice in, or desiring to make any undue claim for protection to native industry in Victorian geology, I think you will agree with me that it is but right that we should try to take inventories of our own possessions for ourselves, and not leave it to outsiders to do it for us.

The following is a list of the Lilydale fossils that have been so well described by Mr. Robert Etheridge, jun., Government Palæontologist of New South Wales, in Nos. 3 and 7, Vol. I, of the "Records of the Australian Museum," there:—Favosites grandipora, Trochus (Scalætrochus) lindströmi, Niso (Vetotuba) brazieri, Cyclonema australis, Cyclonema lilydalensis, Phanerotrema australis, Oriostoma northi, Murchisonia attenuata (?), Bellerophon cresswelli, Ambonychia poststriata. In addition to these, Mr. Etheridge records, without describing, the well-known and world-wide Silurian brachiopod, "Atrypa reticularis," and mentions also that there are three species of the well-known Rhizopod "Stromatopora" yet to be described. The fossils which I myself wish to record, as also occurring in the Lilydale limestone, and as a supplementary list to that supplied by Mr. R. Etheridge, jun., are the following:—

Mollusca and Molluscoidea.

Cephalopoda.—Orthoceratites, sp.; and Discoceras? sp.

Bellerophontidæ.—Tremanotus pritchardi.

Gasteropoda.—Eunema etheridgei, Stomatia antiqua, Tryblidium (Metoptoma) nycteis, Pleurorhynchus (Conocardium) costatus, and Pleurorhynchus (Conocardium) bellulus, Naticopsis lilydalensis.

Lamellibranchiata.—Ambonychia tatei.

Brachiopoda.—Strophomena rugosa, Leptœna transversalis, Orthis elegantula.

Cœlenterata.

Actinozoa.—Heliolites, sp.; Cyathophyllum, sp.

Some of these names will at once be recognised as being those of world-wide Upper Silurian forms, but the following species are new, as far as my knowledge goes, and so I

will venture to name and describe them as such, at least provisionally :—

The first and most important to be described is a shell belonging to the Bellerophontidæ, a group of extinct shells of generalised form, which had characters that are now divided between the Cephalopoda, the Heteropoda, and groups of Gasteropoda, of which Pleurotomaria and Haliotis are respectively the types. It is a *Tremanotus* which I have named T. pritchardi, in compliment to Mr. G. B. Pritchard, a well-known geological friend, who has kindly lent me the best specimen that I have with me, and which he found in the Lilydale quarry some time ago. *Sp. Char. of T. pritchardi* shell discoidal, bi-concave, trumpet-shaped, and very thick, consisting of about five rapidly increasing whorls, forming a deep umbilicus on both sides; spire elliptical in section, and back symmetrically convex. Breadth of the shell about two inches, length from three and a half to four inches. Aperture very much expanded and reflected like the mouth of a trumpet, but more so anteriorly than laterally; the inner surface of expanded outer lip quite smooth. No slit or sinus as in Bellerophon, but the middle dorsal line of the shell is pierced by a row of oval siphonal openings, resembling those of Haliotis, there are about seven of them to an inch of the periphery. The outer surface of the shell is ornamented with spiral fluctuating lines parallel to the dorsal keel, and becoming on the expanded outer lip more flattened, coarser, and more plait-like. There are also the very distinct lines of growth in a transverse and backward direction to the dorsal keel, that are so characterestic of the Bellerophontidæ. The lines in the two directions combining in this shell to give a very distinct fenestrated appearance. T. pritchardi has in general form a near resemblance to "Tremanotus maideni," described by Mr. Robert Etheridge,* from the Hawkesbury (Trias) rocks of New South Wales, and which he regards as a curious survival from Silurian times, but, besides other differences, our fossil is a very much thicker shell.

The next fossil to be briefly described as far as may be from very imperfect specimens, is *Eunema etheridgei*, a gasteropod shell that appears to belong to the Littorinidæ,

* Department of Mines.—Memoirs of Geological Survey of New South Wales. Palæontology I. Invertebrate Fauna of Hawkesbury; Wianamatta Series, by Robert Etheridge, jun.

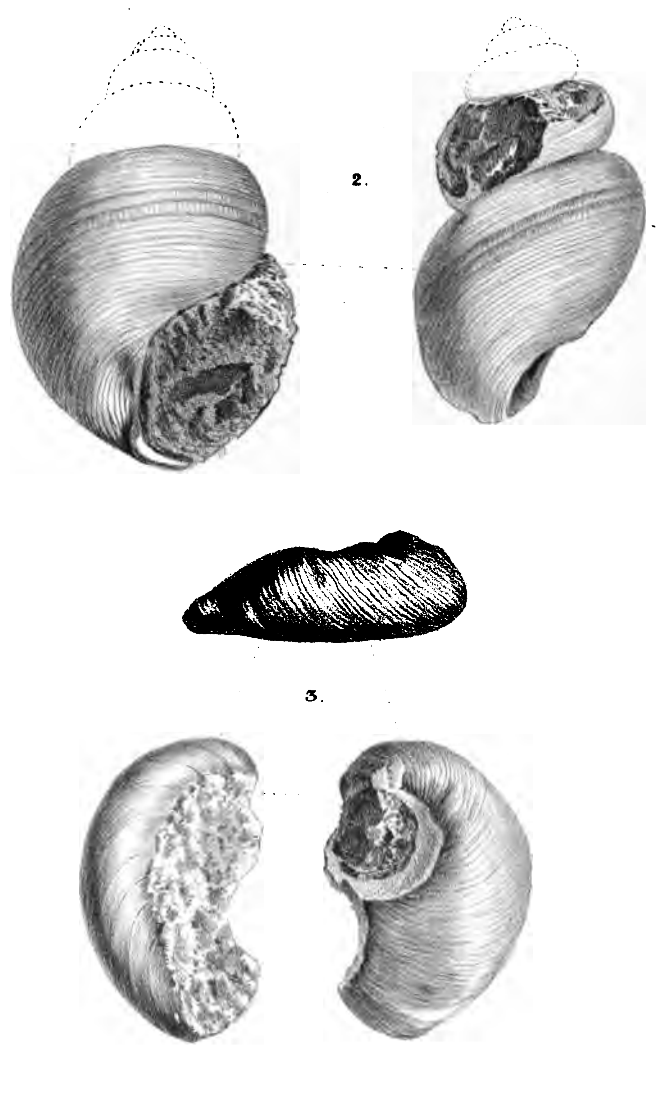
like the Cyclonemas of this formation, which it very much resembles, only that the spire is more elevated. In typical Eunemas, according to Nicholson, "the whorls are more or less angular, and the surface is often adorned with elevated spiral ribs." In our Eunema, however, the whorls are rounded like those of Cyclonema, and are traversed with spiral keels, but more numerous and less distinct than in C. australis, and C. lilydalensis. There is also an indistinct appearance of a spiral band about the middle of the whorls. C. etheridgei is like "E. cirrhosa" of the English Wenlock, as figured in Murchison's Siluria, but has much more numerous keels. I have taken the liberty of naming this shell after the celebrated Palæontologist of New South Wales, who has taken so warm an interest in our Victorian fossils, and which I hope may be still continued, notwithstanding the fact that he is an outsider and lives across the border.

The few other shells which I take to be new, shall be passed over with but very slight notice, as time hastens, and there are three other papers to follow. One is a gasteropod shell, a Stomatia, which I have called "*Stomatia antiqua*," because, as far as I am aware, it is the oldest Stomatia upon record. The whorls are somewhat steeper in the sides, and more flattened than Stomatias usually are, and though the spire is broken off in the only specimen I have, it must have been higher than is usually found in that genus, but in all other respects the appearance of the shell is that of a "Stomatia." The whorls are diagonally crossed with very numerous lamellæ-like lines of growth. The shell is one and a half inches long, and one inch wide. Then there are *two small species of "Pleurorhynchus, or Conocardium"*—lamelli-branchiate shells belonging to the Cardiidæ, one about half-an-inch long, with nine simple ribs on the anterior part of each valve, and about seventeen on the hinder part, and which I have called "*Pleurorhynchus costatus*." And the other species is about one-third of an inch long, with the body of the shell more oblique to the hinge line, more prettily banded and ribbed than the other species, the ribs being crossed with striæ, and the valves having a distinctly fenestrated appearance at the posterior end. This I have accordingly named "*Pleurorhynchus bellulus*."

There are two other shells that I have not figured on that diagram, but have here to show you. I will pass

them over with bare mention, not having yet had time to examine and compare them with other shells. One is a Gasteropod, a *Naticopsis* apparently, which I will call *N. lilydalensis*, if it should turn out to be new; and the other is a lamelli-branchiate shell, an Ambonychia, differing from A. post-striata of Etheridge, and alluded to by Professor Tate, as having a fenestrated ornament on the sides of the valves. If Professor Tate has not already named it, and will forgive my impudence, I will take possession of it in the name of Victorian geologists and call it A. tatei, for I am pretty sure we had found it long before he did.

In concluding, I desire to acknowledge my indebtedness to Mr. D. Mitchell, the owner of the quarry, and also to his foreman, Mr. J. Fuller, for statistical and other information about the quarry; to Mr. G. B. Pritchard, of the Working Men's College, for the loan of fossils; and to Mr. H. J. Stokes, organist of St. John's, Camberwell, for the photographs of the quarry that have been exhibited in illustration of this paper.



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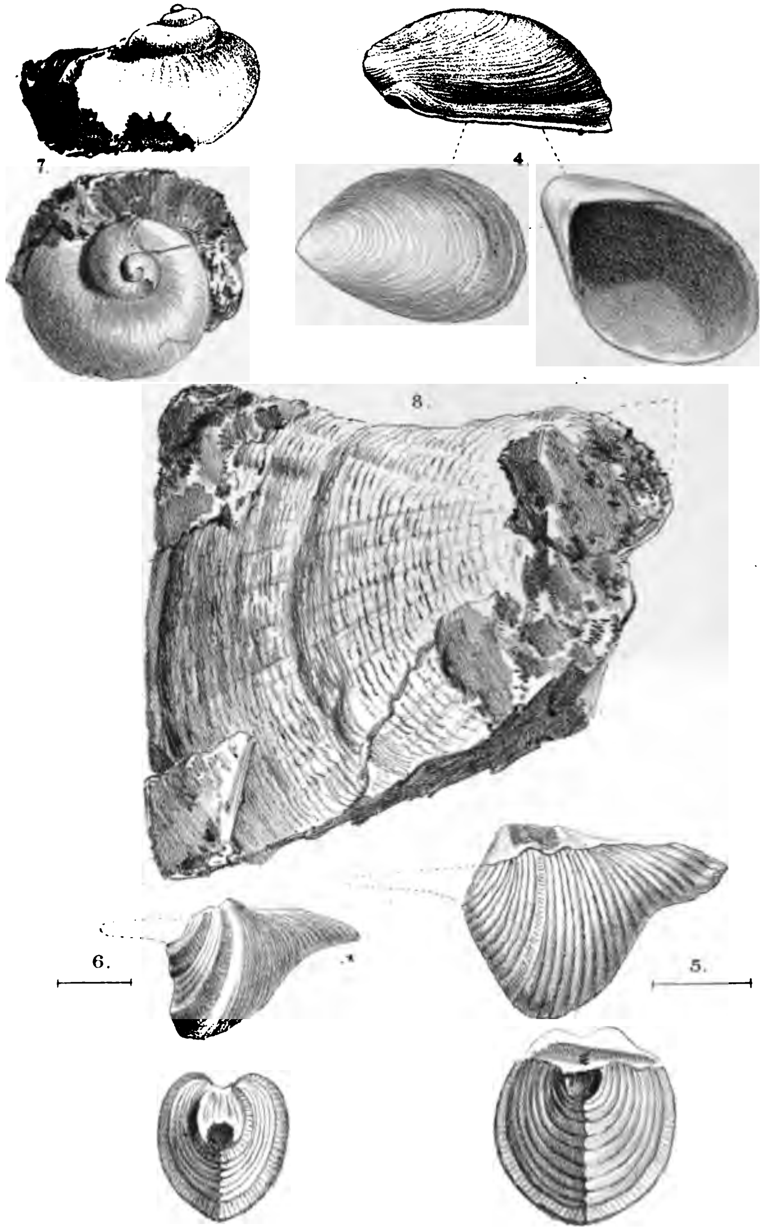

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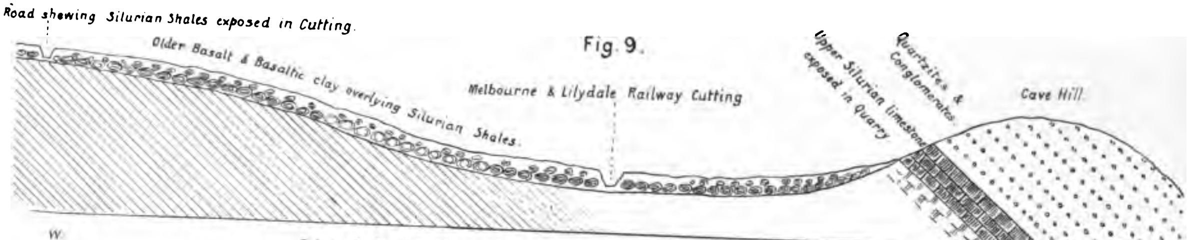
Fig. 9.



Enlarged Section along A B of Plan. length about half a mile.

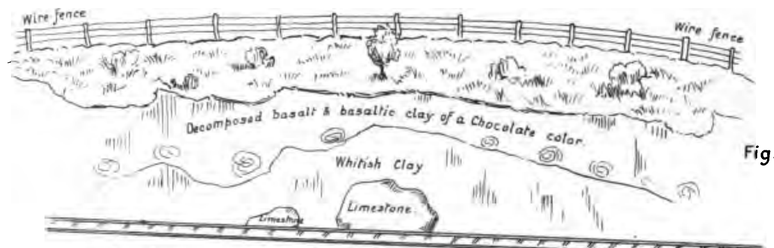


Fig. 10.

View of west side of Cutting of Melbourne & Lilydale Railway about 3/4 of a mile further towards Melbourne than Cave Hill shewing the two bosses of limestone referred to in the paper.

Art. V.—*Preliminary Account of the Glacial Deposits of Bacchus Marsh.*

(With Plates X, XI and XII.)

By Graham Officer, B.Sc., and Lewis Balfour,

Melbourne University.

[Read July 14, 1892.]

The subject of glaciation is one that is always of the greatest scientific interest. Its important bearings on the questions of climate, past and present, and on the problems connected with the evolution and distribution of plants and animals, render it a field where the astronomer, geologist and biologist may meet on common ground. The subject has received its fair share of attention in the Northern Hemisphere, in Europe, America, and Asia, but in the Southern Hemisphere, where the evidence of past glaciation is not so conspicuous, comparatively little has been done in this direction. Any evidence of past ice-action in Australia that may be discovered is of peculiar value, on account of its bearing on the question of the probable cause of ice-ages.

The earliest reference to glacial action in Victoria is made by Selwyn in his work on the Geology of this colony. In this, a conglomerate is mentioned as occurring near Bacchus Marsh, and which contained boulders which he and Mr. (afterwards Sir) R. Daintree considered could only have been brought there through the agency of floating ice.

Mr. James Stirling, F.G.S., and Dr. Lendenfeldt, have described evidences of former extensive glaciation in the Australian Alps. To these discoveries reference will be made later on.

Mr. E. J. Dunn, F.G.S., has contributed two papers on the Glacial Conglomerates of Victoria—one read before the Royal Society of Victoria; the other, in which the first is incorporated, before the Australasian Association for the

Advancement of Science at the 1890 meeting. This conglomerate is described as occurring, among other places, at Bacchus Marsh, and is said to consist of material, the great bulk of which is derived from schistose and other ancient rocks and to contain pebbles, boulders and masses of from 20 to 30 tons weight. Granites, gneiss, schist, quartz-rock, sandstone, lydianite, agate, shale, porphyry, and jasper, &c., are d to occur in it. Many of the included stones are striated, and often flattened on one or more sides; others are well rounded, and others again are rough angular fragments. Erratic blocks of granite occur on the surface at Wild Duck Creek, near Heathcote.

Mr. Dunn is of the opinion that "no other conclusion can be arrived at than that floating ice has been the agent by which the material has been brought into its present position." "Much of the material," he says, "is foreign, and many of the rocks are not known to occur at present in this Continent anywhere near Victoria." He also considers the conglomerate at Wild Duck Creek to be very similar to the Dwyka glacial conglomerates of South Africa. Mr. Dunn's description is very general, and the evidence on which his conclusions are based is somewhat vague and wanting in specific detail.

Mr. T. S. Hall, M.A., has also given a short account of these deposits at Heathcote in the "Victorian Naturalist," (Vol. VIII, No. 2). He also considers the beds to be of iceberg origin.

Victoria is divided into two main areas by a continuation of the Australian Cordillera, known as the Main Divide, or Great Dividing Range. This extends from Forest Hill on the east to the Grampians on the west. In the eastern part of the south division we have the South Gippsland and Westernport Ranges, of which the Southern Spur forms a leading feature. West of Port Phillip we have the isolated Otway Ranges. The Main Divide reaches its highest elevation in its eastern portions, Mount Kosciusco being over 7000 feet and several other mountains over 6000 feet above sea level. Passing westwards the elevation gradually diminishes. The average elevation is about 3000 feet, but in some places it sinks to 1000 feet above sea level. The average distance from the coast is about seventy miles. There are three main drainage systems—(1) The Murray System, north of the Divide; (2) The South Eastern or Gippsland System, south of the Main Divide and east of the

southern spur; (3) The South Western System, south of the Main Divide and west of the Southern Spur. The Main Divide, according to Murray, is a "longitudinal area of Lower Palæozoic rocks, with granite and trappean intrusions." These may be overlaid by, or flanked by Upper Palæozoic, Mesozoic, and Tertiary deposits.

The Bacchus Marsh district is situated about midway between Melbourne and Ballarat, and thus belongs to the South West Drainage System. The principal streams in the locality are the Werribee and its tributaries, the Myrniong and Korkuperrimul Creeks and the Lerderderg River. The town of Bacchus Marsh is picturesquely situated in a broad extensive valley 343 feet above the sea, and which has probably formed the basin of an ancient lake. On the one side runs the Werribee, and on the other the Lerderderg, the junction of the two streams taking place about a mile below the town. From Bacchus Marsh the country gradually rises to the Dividing Range, only a few miles distant to the north. The rising ground between Bacchus Marsh and the Dividing Range is known as the Pentland Hills.

The so-called glacial conglomerates are well developed in this district and numerous sections exposed to view by the Creeks and various cuttings provide very favourable conditions for their study.

The first section we examined is situated on the Ballarat Road, about three miles on the Ballarat side of Bacchus Marsh, and is at a height of about 750 feet above the sea. The deposit exposed consists of a matrix of clay of a quite unstratified appearance, and of a somewhat variable consistency. It is tough and hard in places, while in others it is softer and less tenacious. The colour is an indefinite patchwork of white, yellow and purple. Through this matrix are scattered irregularly numerous stones of various sizes and sorts, rounded and sub-angular. These stones do not show the slightest trace of arrangement either in size or in position. Some of the stones are waterworn, but many present quite another and distinct appearance. These often show one or more flattened sides, while the edges and ends are frequently rough or sub-angular. Besides these peculiarities many show striated surfaces, the striæ generally running in the direction of the longest axis, but several sets of striæ can often be distinguished. Certain kinds of stones show striæ much better than others.

A hard fine grained argillaceous sandstone varying in colour from a very light to a darker green is the predominating rock-material, and this kind usually exhibits the most marked striations. Another common variety is a blue-black very hard quartzite. These, though commonly exhibiting flattened or facetted sides and angles, seldom show striæ, their surfaces being more often polished.

Granite often occurs though not so frequently as the other kinds of rock. The largest boulders are of this material. One taken from the cutting can be seen lying at the side of the road, which is well flattened on one side. The granite is generally considerably decomposed. At the top of the cutting a large angular fragment of sandstone occurs, while another piece can be seen at the base; whether the latter is *in situ* or not we have not yet determined.

The unstratified nature of this deposit, together with the peculiar nature and want of arrangement of the included stones, at once stamps it as of glacial origin.

A few feet back from the top of the cutting on the south side, an outcrop of white silicious sandstone occurs. We are inclined to think that the glacial deposit is banked up against this, really overlying it.

A short distance below the cutting a small lateral road joins the main one, and on this road, a hundred yards or so from the junction, another cutting exposes a good section. The material exposed is similar to that just described, but is of a more uniform purple colour. It is also somewhat harder. It is quite unstratified and contains numerous well striated stones. On the surface, on both sides of this cutting, glaciated stones are scattered about in great profusion and variety. This deposit apparently overlies sandstones and is continuous with that exposed on the main road.

Before making our next visit to the locality, we wrote to Mr. Charles Brittlebank, of Dunbar farm, near Myrniong, who, we were led to believe, could give us information in our researches. Mr. Brittlebank readily responded, and during our subsequent visits has rendered us much valuable aid. He has accompanied us on most of our expeditions and shown us much hospitality, while his intimate knowledge of the locality, as well as his keen powers of observation, have been of the greatest assistance to us. Mr. Brittlebank informs us that he found glaciated stones in this district four years ago. He thus appears to have been the first to actually prove the glacial origin of the deposits in question.

The valley of the Myrniong Creek for some little distance above its junction with the Werribee is cut through basalt and sandstones and conglomerates to a depth of over 600 feet. Good sections are exposed along this valley.

On the south side, about half a mile above the confluence of the two streams, a depth of over 100 feet of a material similar to that described on the Ballarat Road is exposed. It consists of a mass of yellowish white clay, quite unstratified, and in texture somewhat soft on the weathered surface, but much harder on being penetrated. Numerous stones of all sorts and sizes, from mere grit to boulders several feet in diameter, are scattered irregularly, and without any trace of arrangement throughout this clay. Among these stones, the principal varieties are those occurring in the cutting on the road already described. Chiastolite and other varieties of slate were found, together with quartz, bits of jasper, and a hard, red quartzitic sandstone. Most of these stones are sub-angular, often showing one or more smoothed and flattened surfaces, while the edges and ends are roughly angular; many are well striated and grooved in a characteristic manner. On some large boulders lying at the base of the cliff, the striæ and grooves are exceptionally well developed. This deposit can be traced up the valley for about a quarter of a mile above this point, when it thins out, and is seen to overlie and flank the sandstones through which the valley has been worn. It is overlaid by basalt known as the newer volcanic, and assigned to Pliocene age (Fig. 1).

On the other side (north) of the Myrniong Creek, but nearer its junction with the Werribee, the glacial deposit is again well shown to a depth of about 150 feet. It is much the same as that on the opposite side of the valley, and striated stones are numerous. This extends to within 200 yards or so from the junction of the two streams. It can be traced over the brow of the valley up to about the level of Mr. Brittlebank's house, about 350 feet above the Creek, and about 1100 feet above the sea. It then spreads out over the surface.

It would seem evident then, that the valley now occupied by the Myrniong Creek at this point at any rate is a very ancient one, and was at one time probably almost filled up by this glacial conglomerate. The sandstones and conglomerates through which the valley is worn, were set down as Upper Palæozoic by the Geological Survey; then, on the dis-

covery of three species of Gangamopteris, Professor McCoy assigned them to Triassic times. Last year, more fossils were obtained. These were somewhat fragmentary, but Sir Frederick McCoy thinks he can identify Schizoneura and Zeugophyllites, indicating a lower Triassic age for the rocks in question.

After the glacial material had been deposited in this ancient valley, it was overflowed by basaltic lavas of Pliocene age. Whether the older basalt of Miocene times also overflowed this valley previously to the former, we cannot say with certainty. We have seen no evidence of it at any rate. Since Pliocene times the valley has been again denuded to its present condition.

From the general characters presented by the so-called glacial conglomerates, we were much inclined to the opinion that they would turn out to be, not an iceberg-drift, but in reality till, or boulder-clay—in fact the ground moraine of ancient glaciers. These characters may be summed up as follows:—(1) The unstratified nature of the clayey matrix. (2) The number and variety of the included stones. (3) The striated and glaciated aspect of many of these stones. (4) Their total want of arrangement. In fact, these deposits bear such a striking resemblance in every way to the till of Scotland and elsewhere in the Northern Hemisphere, that it can hardly be doubted that they are of similar origin. Corroboration was therefore to be sought for in the shape of roches moutonnées, or shattered rock surfaces beneath this deposit.*

In the valley of the Myrniong Creek, opposite the section described as occurring on the south side, can be seen rounded, hummocky-looking masses of sandstone, the appearance of which is very suggestive of glacier action. It is very probable that the glacial conglomerate not long since covered these rocks, and thus protected them during a long period from the effects of weathering. It must also be remembered that the glacial conglomerate itself must have been protected for a considerable time by the basalt. The sandstone is hard and massive, and is just the kind of rock on which the abrading and rounding effect of glacier ice would be well represented. Certainly, striæ and grooves are absent, but

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* Having had opportunities of observing the till and other phenomena of glaciation in Scotland, Ireland, and Switzerland, I can vouch for the striking resemblance of our glacial deposits to the boulder-clay of the Northern Hemisphere.—GRAHAM OFFICER.

these may have weathered away. In many parts of the Scottish Highlands, where the whole country shows the rounded and flowing contour characteristic of ice-action, it is often very difficult to find actual scorings and grooves.

Some little distance further up the Creek a section has been exposed by the stream, showing some feet of a hard unstratified material containing striated stones. This was much harder than any we had previously examined, and was traversed by joints. It was seen to be clearly overlaid by sandstones, the junction between the two being very distinct, there being apparently an unconformity. Here a fault occurs through the sandstones and the underlying material, the displacement being about seven feet, and the hade at a high angle. There would seem to be no doubt that the overlying sandstones are continuous with the surrounding ones, which, as we have seen, are probably Triassic. So now it seemed probable that we had to deal with two glacial deposits.

At the junction of the Myrniong and Werribee, the latter stream is seen to be flowing over the highly inclined and sorely denuded edges ot Lower Silurian rocks, here consisting of very hard, fine-grained, well stratified sandstones. On the weathered surface the colour of these is of a patchy yellow rusty colour, but on the fractured fresh surface they are of a light greenish white, or light slaty white colour. On proceeding up the Werribee from the junction, we found ourselves walking over another kind of material, which was seen to rest unconformably on the Silurian rocks, which it closely resembles in colour. The Creek has cut its way through this to the Silurian, so that on the floor of the river course one walks now on a few feet of Silurian, and now on this other deposit, while sections are exposed on both sides of the stream. This deposit consists of an exceedingly hard clayey material, through which are scattered stones and boulders of considerable size, of granite, quartzite, fine-grained hard sandstones (very similar to the underlying Silurian), and quartz. Nearly all these present the flattened sides, and striated and grooved surfaces characteristic of ice action. The stones and boulders at this point are very numerous, and the scorings and scratchings exceptionally well developed. This conglomerate resembles those already described, in the absence of any appearance of stratification, the character of the included stones, and the total want of arrangement of the latter. In fact, it cannot be distin-

guished from boulder-clay or till. However, it differed from those we had yet examined, except the last described, in being so excessively hard and tough, and in being traversed by numerous joints. Till one has actually tried, it is impossible to give an idea of the difficulty of extracting a stone from this material, which will only come away in small angular fragments, in a manner that is peculiarly exasperating. On the north side of the Creek, a short distance from the junction, a section of a similar deposit is exposed, which presents a somewhat stratified appearance; striated stones occur irregularly through this, but they are not so numerous as on the opposite side of the Creek. The appearance of stratification presented may possibly be due to pressure. It is overlaid by basalt.

On proceeding up the Werribee a few yards further on the south side we found a small cliff, where the junction of the conglomerate with the underlying Silurian could be well seen in section. Here was a place where, if the conglomerate were a true till, we might expect to find the underlying rock smoothed and striated, or else shattered. The section exposed showed the Silurian rocks rising in a hummocky way, and closely overlaid by the conglomerate. A closer inspection revealed a certain rounded and facetted appearance, that was very suggestive of ice action. Having found a place where the overlying deposit was thinner than usual, we resolved to clear away a portion, and after some difficulty and hard work succeeded in laying bare a portion of the rock below. We were amply rewarded for our trouble. The Silurian rock presented in a beautiful manner a well smoothed and striated surface, with deeper parallel grooves, all running in a north and south direction, and of the glacier origin of which there could be no doubt whatever. The Silurian strata here dip west, at angles of from 50° to 60°. So it will be seen that the strata are cut across at right angles to the dip, in fact in the direction of the strike. It is quite impossible that this can be due to the action of the Creek, or indeed to the action of water at all. The striæ and grooves point right across the Creek. The contiguous portions of the overlying deposit, when removed, were found to retain perfect mouldings of the grooves and striæ beneath.

This striated and grooved rock surface, taken in connection with the nature of the overlying deposit, leaves no room for doubt as to the glacier origin of the latter, and that it is a

true till, or moraine profonde. This till can be traced down the Werribee to its junction with the Myrniong Creek, and a little way beyond on the latter Creek. It here is apparently overlaid by the Triassic rocks. With heavier tools than we had at our disposal, and a little more time, it would not be difficult to remove more of the till from the underlying Silurian, and thus lay bare more of the moutonnée surface.

A few days after this discovery, we received a letter from Mr. Brittlebank, stating that he had found a further example of roche moutonnée at the lower end of the Werribee Gorge, nearly two miles below its junction with the Myrniong. On our next visit, we accordingly proceeded to the spot, and examined the rocks in question.

The Gorge has been cut to a depth of over 600 ft. through a mass of Silurian rocks, flanked by the Triassic sandstones and conglomerates, the former having formed a ridge or island in the Triassic sea or lake (Fig. 1). The Silurian rocks here consist of slates, finely laminated shales, and hard quartzitic sandstones; quartz veins are frequent, and a dyke of porphyry also occurs. The strata are inclined at the usual high angles, being often almost vertical.

At the place indicated by Mr. Brittlebank we found the till again overlying the Silurian. Here, it presents much the same appearance as that last described, glaciated stones and pebbles being frequent. At this point, at a spot where the till was only about a foot thick, Mr. Brittlebank had laid bare a portion of the underlying rock. An example of roche montonnée was thus exposed to view, which was even better than the one first discovered. More of the overlying deposit was now removed, and a greater surface of the underlying rock uncovered, this being an operation of some difficulty. The surface exposed presented the appearance of three smooth parallel ridges, well scored and striated, with well rounded grooves six or more inches deep between. Here, as before, the striæ and grooves run north and south, in the direction of the strike, and right across the river (Pl. XI). In several places, the rock has been fractured at right angles to the groovings. Photographs of these were obtained. This was by no means the only spot in this locality where roches moutonnées were found. A short distance further up the Creek can be seen a rounded hummock of Silurian rock, which has been denuded of the overlying till. The effects of weathering have obliterated

all striæ and grooves, but the rounded contour still remains. In several other places small portions of the till were removed, and a striated and grooved surface invariably exposed, the direction of the striæ being still constant. The till here is about ten or twelve feet in thickness, and is distinctly overlaid by the Triassic rocks. On the opposite side of the river (south side), a good section is exposed. The till is again seen resting on the Silurian rocks, which here also, as seen in section, appear to have been subjected to the action of ice (Pl. XII). The strata are nearly vertical. The till here is seen to thin out, forming a wedge-shaped mass. It is overlaid by the Triassic rocks which, below the lower end of the wedge, rest directly on the Silurian. The till and overlying formation extend a short distance up the Creek from this point, when they terminate against the uprising ridge of Silurian strata.

There would seem to be little doubt that the Triassic rocks overly the till unconformably. It will now be seen that there are two distinct glacial deposits. Of these, one is overlaid by the Triassic sandstones and conglomerates, and is undoubtedly an ancient till, or moraine profonde; the other overlies the Triassic rocks and is similar to the lower till, except that it is not so hard nor so traversed by joints, which is hardly a matter for surprise.

Numerous well striated stones and boulders are scattered over a great part of the surface between the Ballarat Road and the Myrniong and Werribee streams, up to an elevation of over 1100 feet above the sea. These stones can be traced flanking the ridges that overlook the Werribee. At a point opposite the Gorge, at the lower end, the stones are especially numerous and very well striated. In addition to the commoner varieties, a hard semi-crystalline sandstone, of a dark pink colour, occurs. The stones here overly the Triassic sandstones, and can be traced along a small lateral gully right down to the Werribee. The deposit from which they come is exposed at various points along this gully, and is quite similar in its unstratified nature, and in the irregular arrangement of the included stones to that described before. In places it presents a very hard texture, sometimes somewhat resembling the till below the Triassic rocks, in other places it is softer, but in several places where its junction with the underlying sandstones could be seen, it was so invariably hard and thick that we could not clear any away so as to expose the under-

lying rock. However in places, as seen in section, the latter presented a rounded appearance that was very suggestive of ice action.

At the intake of the Bacchus Marsh water supply on the Werribee, about a mile below the Gorge, where the valley is very broad, a splendid section of a till-like deposit is exposed; there being over 70 feet. The matrix is a yellowish-white clay, very tough and hard, and stones and boulders of the usual kind are scattered through it in a pell-mell fashion, with no trace of arrangement. There is no stratification, but irregular bands occur here and there, sometimes lenticular in form. These bands are in some cases of a fine sandy material; others consist of minute angular fragments of much the same nature as the rest of the deposit, but coarser. These bands are only about eighteen inches or two feet in thickness, and seem to have been formed by the intermittent action of running water. Similar bands and lenticular patches of sand and other material occur frequently in the till of the Northern Hemisphere, having been formed by the action of sub-glacial streams. We have not yet been able to determine definitely the relations of this deposit, but from its nature and position, as well as its great thickness, we incline to the opinion that it belongs to the upper glacial deposit. It occurs again about half a mile further down the river, where good sections of it are exposed. It here does not contain nearly so many stones, while those that do occur are generally small, otherwise it is similar to that last described. We have not found the deposit between this point and Bacchus Marsh along the Werribee.

About four miles up the Korkuperrimul from the bridge on the Ballarat Road, a glacial conglomerate is again met with containing numerous typical glaciated stones. The matrix is exceedingly hard and devoid of stratification. In places, when looked at from one point of view, an appearance of a somewhat irregular stratification can be seen. However, a more careful examination reveals the fact that what are apparently lines of stratification, are in reality curved division-planes, which are probably due to shearing stresses. At one place in this section a departure from the usual irregular disposition of the stones may be observed. The stones are arranged in a sloping fashion, along an inclined plane. This arrangement is sometimes met with in the till of the Northern Hemisphere. At this place also a boulder, about eighteen inches long and somewhat pear-shaped, can

be seen resting in the matrix in a vertical position. Now, if such a boulder were dropped from an iceberg, we might expect it to remain in an upright position in the soft clay, but if so, we should certainly expect to find the clay indented beneath it. Of this, there is not the slightest indication.

A little further up the Creek another section is exposed. Here our till-like deposit rests on massive sandstone, but we were unable to remove sufficient of the former in order to expose the surface beneath. At one point, however, a somewhat remarkable feature occurs. In the sandstone is an oblique gap about four or five feet deep, as if a block had been torn out. This cavity is filled with the overlying material, and two or three flattened and striated stones rest on its lower *side* (not *bottom*). It is difficult to conceive how icebergs could have deposited stones in this manner, while on the other hand it is readily explained on the glacier theory.

The locality between this place and the large quarry, about two miles further down the Creek, we have not yet examined. Between this quarry, situated on the north side of the Korkuperrimul, and the bridge on the Ballarat Road, the valley in which the Creek flows follows approximately the axis of what has once been an anticlinal fold of the Triassic sandstones. Opposite the large quarry, the valley is a little to the right of this axis. Between this large quarry and the Creek, striated stones are numerous. A small lateral gully exposes sections. One of these shows a somewhat loamy clay, in which are irregularly imbedded large angular fragments of sandstone, in appearance very like the underlying rock. Large granite boulders, quartzite, slate, quartz, and fragments of jasper also occur, many showing flattened and striated surfaces.

On the Creek opposite the quarry, a cliff of about 60 feet of the glacial deposit is exposed. It is very similar to that described on the Ballarat Road. It rests on sandstones, the broken ends of which can be seen protruding from the base of the deposit, which towards the top, presents a somewhat stratified appearance. On the opposite side of the Creek, high cliffs of basalt (newer) occur. This has evidently filled up the valley at this place, probably covering the glacial deposit and having since been denuded away to its present state.

Several hundred yards further down the Creek, on the right hand side, a section exposed shows a few feet of an

unstratified material bearing striated stones, and overlaid by very irregularly stratified tumultuous-looking sandstones. These sandstones are very probably simply beds associated with the glacial deposit. This is indicated by their tumultuous appearance, and by the fact that we found several well scored stones in them. Moreover, a small patch of a material similar to that beneath occurs intercalated with them. The basalt is banked right up against this, the line of junction being almost vertical. The whole mass probably formed a ridge in the valley at the time the basalt overflowed it. Striated stones can be traced for about a third of a mile further down this valley, on the right hand side, being overlaid by basalt (Fig. 2) The characteristic stones of the glacial deposit can be traced along the hills flanking the valley on the left. At one spot, between the big quarry and another smaller one further down the valley, a conglomerate occurs, which consists of a loamy matrix, in which are scattered angular fragments, in all positions, of soft sandstone. This rests on the denuded edges of well stratified Triassic sandstone, from which the fragments have apparently been derived.

Some distance further on, a small quarry occurs in the Triassic sandstones, which here dip E.S.E. about 35°. The glacial conglomerate can be traced to about 200 feet above the Creek, and in the quarry can be seen in section resting on the sandstones to a depth of about five feet. On the left hand side of this section, the junction is very marked, while tracing it to the right, it becomes very indefinite by the disintegration of the sandstone. This section is at right angles to the dip. At the same quarry, another section is exposed at right angles to the former. This exhibits remarkable and important features. Beginning at the lower end of the section, a pell-mell accumulation of rough angular and rounded blocks, up to eighteen inches and two feet in diameter, embedded in a loamy matrix, is seen overlying soft purplish stratified clays or shales. The latter are much broken up and disintegrated at their junction with the overlying deposit. Angular blocks of sandstone in every conceivable position are mixed up in the ruin, and in fact a definite junction it is almost impossible to distinguish. Further along the section, this mixed material merges into a purplish mass of clay, overlying broken and shattered sandstones. (The shales and sandstones are of the same formation.) This purplish clay, which is evidently derived

from the shales, presents the appearance of having been pushed over the sandstones, angular blocks of which are scattered through it. A little further along, a large irregular fracture in the sandstone occurs, being seven or eight feet deep. This is literally stuffed with stones and boulders of the various kinds met with in the glacial conglomerate. Many of these show flattened and striated surfaces. A granite boulder, over a yard in diameter, is jammed into the bottom of this fracture, while broken and angular fragments of the sandstone are also scattered through it, the whole being imbedded in a loamy clay-like material, which seems to have been squeezed into the fracture (Fig. 3). At several other sections exposed in this quarry, similar appearances can be noted. The sandstone has been fractured, and the glacial material literally injected into the cracks and fissures. Several striated stones were picked out from one of these fissures.

It will be seen that, as in the case of the Myrniong Creek, the glacial deposit lies in an ancient valley of denudation. It was probably overflowed by Pliocene basalt, which would thus be the means of protecting the underlying formations during a considerable period. We could not find any more traces of the glacial material between this place and the Werribee.

This concludes the evidence we have so far collected, and it all points irresistibly to the conclusion, that glacier-ice has been the agent by which the effects described have been accomplished. No iceberg theory will account for the facts presented at the quarry. How will such a theory account for the fracturing of the underlying rocks, and the ramming of the fractures with large erratic boulders and the material in which these boulders are imbedded? On the other hand, these are facts which are readily explained on the glacier hypothesis. In the Northern Hemisphere shattered surfaces are frequently met with below till. In his "Great Ice Age," p. 16, Prof. James Geikie says:—"Soft sandstones and highly jointed rocks . . . often show a broken and shattered surface below till; sometimes, indeed, thick sandstones appear 'broken up' to a depth of many feet below boulder-clay, the coarse angular débris shading gradually into till of the normal type." This corresponds exactly with the features presented at the quarry, where the sandstones are soft and easily disintegrated. Cases in Scotland and elsewhere in the Northern Hemisphere are not uncommon, where the

shattered surface of the underlying rock is "stuffed" with erratic stones and boulders.

The conclusion, then, to which we are led is, that the deposits we have been considering constitute a true till, or moraine profonde. This is borne out by further considerations. It is worthy of note, that the stones occurring in this till, at the quarry we have been speaking about, are not nearly so well striated as those occurring in the region of the Werribee Gorge. In the former case, we have seen that the underlying sandstone is very soft, and would not striate stones well; on the other hand, the underlying rocks in the region of the Gorge are much harder, consisting to a great extent of conglomerates, just the kind of rocks that would produce marked scorings on the stones of the till.

These are specific evidence against the iceberg theory. There are also more general arguments. These arguments have been used before to refute the iceberg hypothesis of the origin of the boulder-clay in the Northern Hemisphere, and they apply equally well here.

Mr. Dunn describes the so-called glacial conglomerate, besides being found at Bacchus Marsh, as occurring on both sides of the Dividing Range, at Wahgunyah, Rutherglen, The Springs, El Dorado, Wooragee, Tarrawingee, Baddaginnie, at various points on the road between Wangaratta and Kilmore, north east of Costerfield, Wild Duck Creek (west of Heathcote), underlying the auriferous deposits at Carisbrook and Creswick. South of the Dividing Range, it is met with about four miles east of Gordons, Barrabool Hills, and near Foster in South Gippsland. Thus it will be seen that the deposit is widely distributed, and it appears to be of considerable thickness, being over 100 ft. in several known instances.

It has been shown (Croll, "Climate and Time;" Geikie, "Great Ice Age," &c.), that the amount of material carried by icebergs is quite inconsiderable, and what is carried generally consists of rubbish and angular blocks that have fallen on the surface of the parent glacier. In the case of the ice-sheet that is at present desolating Greenland, the surface of the ice is very free from débris of any kind, and so it is quite a rare thing to find an iceberg shed from one of the vast glaciers of that country bearing any material at all. Yet a tremendous amount of erosion must be going on, and the eroded material is being accumulated beneath the ice as a moraine profonde, although

prodigious quantities must be carried away by sub-glacial streams. Dr. Wright ("Ice Age in North America") calculates that from the great Muir glacier in Alaska over $33\frac{1}{4}$ million cubic yards of sediment is annually carried away by sub-glacial streams. Little, if any, of the sub-glacial material can be carried away by icebergs—a few stones, perhaps, frozen into the bottom of the bergs. The finer material carried away by streams from beneath these great glaciers must inevitably be stratified, and well stratified, as the quantity of material brought down must vary considerably from time to time. Even if much fine matter were carried by icebergs, it would inevitably be re-assorted by the water; the stones, too, would assuredly show some trace of arrangement.

In the deposits we have been considering, the absence of stratification and the total want of arrangement of the included stones, are their chief and most striking characteristics. Then again, in the great mass of the sections we have examined angular fragments are comparatively rare, except as we have seen, where the till rests on the underlying rock. So here again, we have a strong argument in favour of the glacier theory.

Further, these deposits are found up to a height of 1400 ft. at Ballan; so, to account for them on the iceberg theory, we would require a submergence of at least 2000 ft. to allow icebergs to float, and as icebergs can only transport material from higher to lower levels, it is quite impossible to account for the mingling of fragments of the underlying rock in the overlying till, at an elevation not exceeding 800 ft. above the sea. Besides, such a submergence would considerably diminish the area from which the deposits could be derived, and their extent indicates a large surface. Again, such a submergence would tend to produce climatic conditions which would be quite opposed to the production of glaciers, even were the astronomical conditions favourable. It must also be observed that, so far as we have seen, these deposits are quite unfossiliferous.

Mr. Dunn states that much of the rock material occurring in the till is not known at present to occur *in situ* on this Continent anywhere near Victoria. Daintree remarks that a granite occurs in the formation at Bacchus Marsh, which he had not observed south of Queensland. However, as he has not described this granite, it would be difficult now to identify it. We would reply to this that further search will

probably reveal the sources of this material. The geology of Victoria has not been so fully worked out as to warrant us asserting that a certain kind of rock does not occur *in situ*. Then again, it must be remembered that these deposits are anterior—as we shall show—to the Miocene and Pliocene lava flows, and probably to the Miocene leaf-beds, so that, not to speak of the effects of denudation, a a great deal of the then rock surface is now concealed.

Of the various kinds of rock met with in the till in the Bacchus Marsh district, the great majority are derived from Silurian rocks, which form the main part of the Dividing Range. In the Werribee Gorge several kinds of slate occur, which are identical with slates found in the till. Quartz veins are also numerous in the Silurian rocks. We also noted a quartzitic sandstone in the Gorge, which is very similar to fragments found in the till. Several varieties of quartzite occur in the till which we have not yet seen *in situ*, but we have not yet examined the Ranges to the north, and it is very probable they will be found there, as quartzites frequently occur in the Silurian. Fragments of schistose rocks have also been observed in the till, and these occur *in situ* to the north.

Several kinds of granite occur in the till. Granite is found *in situ* in the locality, and among the granite boulders some occur that seem identical with this granite. A very coarsely crystalline variety is also met with, the crystals of felspar being sometimes over an inch in length. Though we ourselves have not seen this in place, yet the Geological Survey report a granite with very large crystals of felspar as occurring in this locality. Pegmatite and aplite also are found in the till. As both of these may occur as veins in other granite, it would not be surprising if they have been overlooked. It is not unlikely even that they may be now concealed beneath the basalt that is well developed in this district.

Summing up, then, the results of our investigations, it would appear that two main points are clearly brought out. The first of these is, that there are two distinct glacial deposits; and the second, that both of these deposits are due to glacier ice, and not to icebergs—in fact, both being moraines profondes. Both are of similar character, except that the lower one is more indurated and jointed. Of these, the latter has been seen to closely enwrap the smoothed, grooved, and furrowed surfaces of Silurian rocks, of the

glacier origin of which there can be no doubt. It is useless at this stage of geological inquiry to maintain that icebergs can produce roches moutonnées. A full discussion of this point may be read in Dr. Croll's "Climate and Time," Geikie's "Great Ice Age," and in "The Labrador Coast," by Dr. Packard. In connection with the upper till, though no undoubted roches moutonnées have yet been met with, yet, as we have seen, shattered rock surfaces below the till are found, which may be said to be quite as characteristic of the action of glacier-ice as a smoothed and moutonnée surface.

It now becomes a most important and interesting question to determine the respective ages of the two tills. It seems certain that we must look to astronomy for the explanation of ice ages. Dr. Croll's celebrated theory has, until now, notwithstanding considerable adverse criticism, been the most satisfactory explanation offered. Recently, however, Sir Robert Ball in his little work "The Cause of an Ice Age," has re-stated the astronomical theory, pointing out an error made by Croll. It would be beyond the scope of this present paper to enter into a discussion on the cause of ice ages, it will suffice to say that Sir Robert Ball has stated the case with great force and clearness. The theory as it now stands shows that when the astronomical conditions for the production of extensive glaciation arise, then we have a period during which several glacial epochs alternate with genial epochs between the two hemispheres, the length of each epoch being 10,500 years. The conditions for this state of things then gradually disappear, and do not occur again till after the lapse of long ages. Sir Robert Ball says he makes no attempt to state the date of the last glacial period, nor to say when the next is to take place. So, according to this theory, using the term "period" to embrace several glacial and genial "epochs," we should expect to find evidence of glaciation in both hemispheres during the same period, though not necessarily to the same extent, for of course the astronomical conditions for glaciation are liable to considerable modification by the existing distribution of land and sea, and the elevation of mountain chains.

Now, taking the case of our lower till first, we have seen that it is overlaid (apparently unconformably) by rocks which have been assigned to Lower Triassic age. In the Permian Period in the Northern Hemisphere, there are clear indications of a glacial epoch or epochs. In England, Dr.

Ramsay describes "brecciated conglomerates," consisting of "pebbles and large blocks of stone, generally angular, imbedded in a marly paste." Many of these stones are as well scratched as those found in modern moraines, or in boulder-clay. Similar boulder-beds occur in Scotland, Ireland, and Germany. Mr. Wallace ("Island Life") states that these physical indications are corroborated by a consideration of the life of the period, which is characterised by its poverty. In India, similar Permian boulder-beds occur, in which large striated stones and boulders are found. In one instance, the rock surface beneath this deposit was glacially scored and striated. These beds have been correlated with similar ones in South Africa, also of Permian age. Mr. G. W. Stow has, according to Dr. Ramsay, given elaborate accounts of these South African boulder-beds. He says that in Natal the great masses of "moraine matter" not only contain ice-scratched stones, but the underlying rocks are well rounded and mammilated, and covered by "deeply incised glacier grooves" in a direction that at last leads one to the pre-Permian mountains, whence the stones forming the moraines have been derived. In Natal, the striated rocky floor is only 30° south, and in India, only 20° north of the equator.

That evidence of severe glaciation should be found in the same period in both hemispheres, and so near the equator—being actually within the tropics in one case—is a strong argument in favour of the astronomical theory, betokening a much wider cause than mere local elevation. This being the case, we might expect to find traces of a glacial period during Permian times here in the more southern parts of Australia. The position of our lower glacial conglomerate, or till, is quite compatible with its being of Permian age, and when to this we add the considerations just noted, this conclusion is much strengthened. There is a strong break in the flora at the close of the Permo-carboniferous series in New South Wales (Prof. David, Address A.A.A.S., 1890). It is possible that this break may correspond with a Permian glacial period.

Now, as regards our upper till. We have not as yet been able to arrive at any very definite conclusion as to the age of this deposit. As we have seen, it lies on the denuded surface of the Triassic rocks, and is certainly overlaid by the Pliocene basalt. That it is also overlaid by the older basalt admits of little doubt, for although this basalt occurs

in the locality, yet we have never found a trace of any volcanic material in the till. The same reasoning applies as to its relation to the Miocene leaf-beds that are well developed in the district. These beds consist for the most part of hard clay-ironstone, in which leaf and plant impressions are very numerous, and as a rule exceedingly well preserved. As we have not found any fragments in the till that in any way resemble the material of these beds, it seems highly probable that the upper till is pre-Miocene.

In Europe, we have evidence of glaciation in Eocene times. In the "Flysch" of Switzerland, huge erratics occur. One of these measured 105 ft. in length, 90 ft. in breadth, and 45 ft. in height (Croll, "Climate and Time," p. 305). Although the Eocene fossils, both in Europe and Australia, indicate a mild climate, yet, as has been pointed out by Croll and other eminent authorities, the life of a glacial epoch would be characterised by negative conditions. As it is of the very essence of the astronomical theory of ice-ages that glacial alternate with genial epochs, it is only to be expected that the life of the genial epochs would be the more likely to be preserved. So it is possible that out upper till is Eocene; this, however, we merely throw our as a suggestion, in the absence of any further evidence at present. Considering the great amount of erosion that took place in Upper Mesozoic and early Tertiary times, it seems improbable that this deposit is earlier than Eocene.

Mr. Stirling and Dr. Lendenfeldt have described undoubted evidences of glaciation in the Australian Alps. These gentlemen found glaciated surfaces on Mt. Cobberas at elevations between 6000 ft. and 4000 ft. above the sea, on Mt. Pilot, and on Mt. Kosciusco. Erratics of huge basaltic boulders occur in "linear extension for miles" in the Reewa River and Snowy Creek valleys, the nearest basaltic outliers being twenty miles away. Perched blocks of hornblende porphyrite occur on "crests of spurs and sidelings" in a regular descending series from near the summit of Mt. Bogong towards the Reewa valley, many of them resting on smoothed surfaces of pegmatite. Moraines occur at the base of Mt. Bogong, at 1000 ft. above sea level. Similar evidences of former glaciation have also been described by Mr. Stirling as occurring in the Livingstone valley, Parslow's Plains, and elsewhere in our Alpine regions.

There would seem to be no doubt that the glaciation indicated by these evidences in the Australian Alps is of

much more recent age than that represented by the upper till at Bacchus Marsh. The presence of erractics of basalt, in "linear extension" along the valleys and on the slopes of the Alps is sufficient to show this. Dr. Lendenfeldt considered that this period of glaciation only terminated between 2000 and 3000 years ago, but, as Professor Hutton has shown, there is no evidence to sustain this. Professor Hutton has expressed the opinion that there was no evidence to indicate that the Southern Hemisphere had ever had a glacial period. That glaciers had formerly existed in the Australian Alps, he has explained on the hypothesis of a local elevation of the Alps, to about 3000 feet above their present level. Now this glaciation took place since Miocene times, as is shown by the basaltic erratics. Mr. Stirling has assigned it to the Pleistocene Period. It is impossible that it can be earlier, for if it were, the erractics would have long ago disappeared from their positions on mountain sides and spurs.

During the Pliocene Period we have evidence, in the distribution of marine gravels, of a submergence of nearly 1000 feet below the present level, and since then the land has gradually risen to its present condition (Murray). In his address to the Biological Section of the A.A.A.S., at Hobart, Professor Spencer says:—"We must conclude from the mammalian fauna, that there has been no absolute land connection between South-east Australia and Tasmania since practically the end of the Tertiary Period or early in Pleistocene times, as otherwise it would be impossible to account for the absence, not only of the dingo, but of the large and specialised diprotodont fauna, of which the Pleistocene Period saw the rise and fall upon the mainland." From the evidence supplied by raised beaches, and by the great depth to which many of our river channels have been cut, it is apparent that the land has been gradually rising for a considerable period. It is thus pretty certain that, since the beginning of Pleistocene times, the land surface has never stood higher, relatively to the sea, than it does now, and in Pliocene times, as we have seen, there was a submergence of nearly 1000 feet below the present level.

If denudation has been the means of reducing the height of our Alpine regions by about 3000 feet since the last glaciation took place, then it would be quite impossible for lines of erratic boulders and perched blocks on mountain spurs to be preserved. Many of these, according to Mr.

Stirling, even yet show striated and grooved surfaces. If the mountains had suffered much denudation, the striæ and grooves would certainly have been removed and roches moutonnées would have vanished—except where protected by overlying deposits—long ago.

So then, seeing that the theory of greater elevation cannot be sustained, we must look in another direction for the explanation, and we have the astronomical theory at hand. According to this theory, we should expect to find evidence of a Pleistocene glacial period here, corresponding with that of the Northern Hemisphere. As we have seen, this is the period to which Mr. Stirling has referred this latest glaciation of the Australian Alps. As eminent authorities have already observed, in trying to realize the probable effect of astronomical conditions favourable to glaciation in the Northern and Southern Hemispheres respectively, the great proportion of sea to land that now obtains in the south must always be borne in mind. The effect of this, in the present distribution of land and sea, would undoubtedly be to mitigate these conditions. In Pleistocene times, there is no evidence to show that our mountains were appreciably higher than now; it seems more probable that our land surface stood actually lower. So that the astronomical conditions which, during this period, resulted in producing such a severe glaciation in the Northern Hemisphere, were probably so mitigated in the Southern Hemisphere that glaciers only appeared in the higher mountains.

Mr. G. S. Griffiths, in a paper on the "Evidences for a post-Miocene Glacial Period in Victoria," describes heavy boulder washes, distributed in many parts of the Colony. These "washes" are ascribed to glacial action. Though the evidence for this is not conclusive, yet it is by no means improbable that these heavy deposits of boulders—many of them basaltic—were formed at the period of the last glaciation of the Alps, when the precipitation was much greater than now. The Dividing Range, except in its eastern parts, not being high enough for the production of glaciers, in the short hot summers of the epoch vast floods from melting snow swept down from the mountains, swelling the rivers and depositing these boulder beds.

At the two earlier periods of glaciation we have indicated, it is not improbable that there was a greater southward extension of land by way of Tasmania than now obtains. In Upper Palæozoic times, the Main Divide must have stood

many thousand feet higher than it does now. In Eocene times, though enormous denudation had then taken place, this mountain chain must have been very much higher than now. Under these conditions, the glaciation during an ice age might be of considerable severity.

We would thus appear to have evidence of three periods of glaciation in Australia, which may be provisionally assigned as follows :—(1) One in Permian times, of considerable severity; (2) one in Eocene times, also severe; (3) one in Pleistocene times, mild, being represented only by glaciers in the higher mountains. At these periods then, it would appear that the Dividing Range nourished great glaciers which radiated outwards, and, in the two earlier periods at least, spread to some distance over the lower ground. Beneath these glaciers the till, or glacial conglomerate, was accumulated as a ground moraine.

Undoubted evidence of glaciation has been adduced by Professor Tate and Mr. G. B. Pritchard from South Australia, and traces have also been noted in Tasmania, although Mr. Johnston remarks ("Geology of Tasmania") that there is no evidence there to show that a glacial period has ever taken place. However, it will seem strange if further evidence from Tasmania be not forthcoming.

In concluding this paper, we would urge the careful examination and mapping of our glacial deposits, and the collection of all evidence bearing upon them. In the words of Sir Robert Ball—"A strict search for glacial indications among all deposits, primary, secondary, and tertiary, would be one of the most valuable pieces of scientific work possible at the present time."—("Cause of an Ice Age," p. 149).

LITERATURE.

Prof. David—"A Correlation of the Coal-fields of N.S.W." A.A.A.S., 1890.

E. J. Dunn, F.G.S.—"Notes on the Occurrence of Glaciated Pebbles and Boulders in the so-called Mesozoic Conglomerate of Victoria," Proc. Roy. Soc. Vic., Vol. XXIV, Pt. 1. "The Glacial Conglomerates of Victoria," A.A.A.S., 1890.

G. S. Griffiths, F.G.S.—"Evidences of a Glacial Period in Victoria during post-Miocene Times," Trans. Roy. Soc. Vic., Vol. XXI.

T. S. Hall, M.A.—" Victorian Naturalist," Vol. VIII, No. 2.

Prof. Hutton, F.G.S.—" The Supposed Glacial Epoch in Australia," Proc. Lin. Soc. N.S.W., Vol. X, Pt. 2.

R. M. Johnston, F.G.S.—" The Geology of Tasmania."

R. Von Lendenfeldt, Ph. D.—" The Glacial Period in Australia," Proc. Lin. Soc. N.S.W., Vol. X.

Sir Frederick McCoy, K.C.M.G., F.R.S., &c.—" Prodromus of the Palæontology of Victoria," Decades II and IV.

R. A. Murray.—" Geology and Physical Geography of Victoria."

Prof. W. Baldwin Spencer, M.A.—" The Fauna and Zoological Relationships of Tasmania," A.A.A.S., 1892.

Jas. Stirling, F.L.S., F.G.S.—" Notes on Some Evidences of Glaciation in the Australian Alps," Trans. Roy. Soc. Vic., Vol. XXII. " On Some Further Evidences of Glaciation in the Australian Alps," Proc. Lin. Soc. N.S.W., 1886.

Annual Report of the Mining Department of Victoria for 1891, p. 30.

Also,

Sir Robert Ball.—" The Cause of an Ice Age."

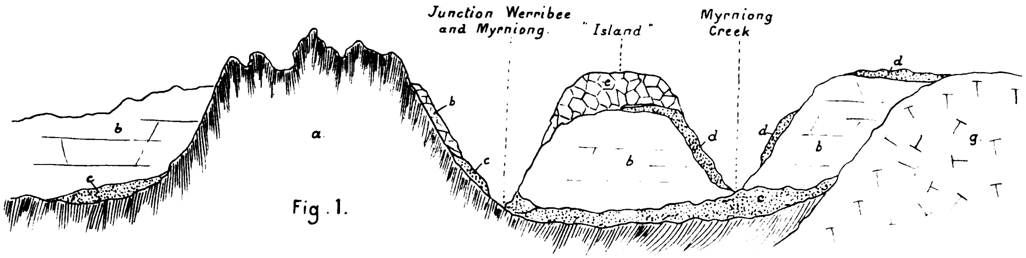
Dr. Croll.—" Climate and Time."

Prof. Jas. Geikie.—" The Great Ice Age."

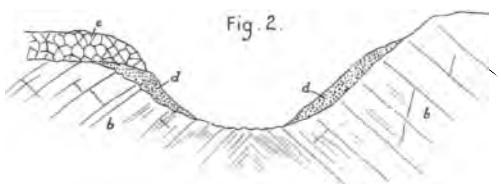
Dr. Packard.—" The Labrador Coast."

Dr. Ramsay.—" Nature," Vol. XXII, p. 389.

Dr. Wright.—" The Ice Age in North America."



Ideal Section through Werribee Gorge to junction with Myrniong, thence across "Island"
(Island = local name for area included between Werribee and Myrniong.)



Section accross Korkuperrimul Creek opposite Small Quarry.

Fracture in Triassic Sandstone with granite boulder at bottom.

a. Lower Silurian. b. Triassic (sandstone & conglomerate) c. Lower Till. d Upper till. e Basalt g Granite.

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ART. VI.—*Synopsis of the Australian Calcarea Heterocœla; with a proposed Classification of the Group and Descriptions of some New Genera and Species.*

By ARTHUR DENDY, D.Sc., F.L.S.

Demonstrator and Assistant Lecturer in Biology in the University of Melbourne.

[Read September 8, 1892.]

1. INTRODUCTORY REMARKS.

Owing to the reduction of the Government grant to the Royal Society, it has been found impossible at present to continue the publication of the volume of the Transactions which the Council of the Society generously set apart for "A Monograph of the Victorian Sponges." Under these circumstances the Council has kindly agreed to my proposal to divide the work by publishing in the Proceedings of the Society only the necessary systematic portion, without illustrations, and publishing the anatomical portions, for which numerous illustrations are indispensable, elsewhere. It is hoped, however, that the continuation of the Monograph in its original form may be carried out at some future date.

I have in my possession, in addition to the very fine series of Victorian Heterocœla collected by Mr. Bracebridge Wilson, a number of very valuable specimens, including several remarkable new species, from other parts of Australia, and it seemed desirable to incorporate descriptions of these in the present communication. I have also a number of fragments of type specimens, generously forwarded to me by the authorities of the British Museum, which brings the total number of species of Australian Calcarea Heterocœla in my collection up to forty-seven.

Up to the present time sixty-two species of this group of sponges have been described from Australian seas, chiefly by Hæckel, von Lendenfeld, Poléjaeff and Carter. Sixteen new species are described in the present paper, which brings the total number of Australian species of Calcarea Heterocœla up to seventy-eight. In order to make the work as complete as possible, I have decided to include, not only descriptions or notes of the forty-seven species which I have been able to study for myself, but also references to those species which I have not seen, and thus to provide a complete Synopsis of the Australian Calcarea Heterocœla.

In order to arrange the species satisfactorily, I have been obliged to adopt a classification which has many new features. This classification has not been arrived at hastily, nor without careful consideration of the work of previous writers. It is impossible to justify it fully in this place, because it is based upon a minute study of anatomical details and a careful consideration of historical questions of priority in nomenclature into which I have not space to enter. I intend, however, to publish a paper on the minute anatomy and classification of the group in another place, in which these questions will be fully discussed; and, in the meantime, I may perhaps point out that the classification proposed is based upon the careful anatomical examination of a very large number of species.

It will be seen that more stress is laid upon the arrangement of the skeleton than is usual at the present day, and less upon the form and arrangement of the flagellated chambers, which I find to vary considerably, even within the limits of a single species. This change certainly facilitates the identification of specimens, and will probably be welcomed by those workers who have not at their disposal the elaborate appliances required for the preparation of stained microscopical sections.

Poléjaeff* clearly showed that no hard and fast line could be drawn between the Sycons and Leucons of Hæckel. This idea was followed up by von Lendenfeld, who has created a special group, the *Sylleibidæ*,† to include the intermediate forms. This group, however, seems to me to be very artificial, as, judging from my own observations, it appears that

* Report on the Calcarea of the Challenger Expedition.

† See especially "Die Spongien der Adria. I. Die Kalkschwämme." Zeitschrift für Wissenschaftliche Zoologie, Vol. 53, 1891.

the transition from the Sycon to the Leucon type of canal-system has not taken place along a single line of descent, but along several. Here, as in other cases, we must classify by an assemblage of characters. The canal-system alone is by no means sufficient, though, when taken in conjunction with the skeleton, it is often of great value.

In enumerating the various genera and species I have not attempted to give a complete list of synonyms and references, as this would have taken up a large amount of space. In the case of the species, however, I have given those synonyms and references which are most important.

My warmest thanks are due to Mr. J. Bracebridge Wilson for the bulk of the specimens here described, to Mr. Thos. Whitelegge for a very valuable collection from Port Jackson, to the Adelaide Museum for some very interesting specimens from St. Vincent's Gulf, to Professor Spencer for a number of specimens from Port Jackson, to Sir Frederick M'Coy for permission to examine the collection in the Melbourne National Museum, and to Dr. Günther for fragments of type specimens in the British Museum.

2. Proposed Classification of the Calcarea Heterocœla.

Order HETEROCŒLA, Poléjaeff.

Calcareous sponges in which the collared cells are confined to more or less well-defined flagellated chambers.

Family 1.—Leucascidæ.

Flagellated chambers very long and narrow, copiously branched; communicating at their proximal ends with exhalant canals which converge towards the oscula; their blind distal ends covered over by a dermal membrane pierced by true dermal pores which lead into the irregular spaces between the chambers. Skeleton consisting principally of small radiates irregularly scattered in the walls of the chambers and exhalant canals and in the dermal membrane.

GENUS I.—*Leucascus*, nov. gen.

Diagnosis.—The same as that of the family.

(For species see Part 3 of the present paper.)

FAMILY 2.—SYCETTIDÆ.

Flagellated chambers elongated, arranged radially around a central gastral cavity, their distal ends projecting more or less on the dermal surface and not covered over by a continuous cortex. Skeleton radially symmetrical.

GENUS II.—*Sycetta* (Hæckel, *emend.*)

Diagnosis.—Radial chambers not inter-communicating. Articulate tubar skeleton. No tufts of oxea on the distal ends of the chambers.

(For example see Part 3 of the present paper.)

GENUS III.—*Sycon* (Risso, *emend.*)

Diagnosis.—Radial chambers not inter-communicating. Articulate tubar skeleton. The distal ends of the chambers provided each with a tuft of oxeote spicules.

(For examples see Part 3 of the present paper.)

GENUS IV.—*Sycantha*, von Lendenfeld.

Radial chambers long, united in groups; those of each group inter-communicating by openings in their walls and each group with a single common opening into the gastral cavity. The radial chambers have freely projecting distal cones surmounted by oxeote spicules. Tubar skeleton articulate.

No Australian species of this genus has yet been found. The type is von Lendenfeld's *Sycantha tenella.**

FAMILY 3.—GRANTIDÆ.

There is a distinct and continuous dermal cortex covering over the chamber layer and pierced by inhalant pores.

* "Die Spongien der Adria. I. Die Kalkschwämme," p. 51.

There are no subdermal sagittal triradiates or quadriradiates.* The flagellated chambers vary from elongated and radially arranged to spherical and irregularly scattered, while the skeleton of the chamber layer varies from regularly articulate to irregularly scattered.

GENUS V.—*Grantia* (Fleming, *emend.*)

Diagnosis.—The elongated flagellated chambers are arranged radially around the central gastral cavity; they are not provided with tufts of oxea at their distal ends, but are covered over by a dermal cortex composed principally of triradiate spicules and without longitudinally disposed oxea. An articulate tubar skeleton is present.

(For examples see Part 3 of the present paper.)

SUB-GENUS.—*Grantiopsis*, nov.

Diagnosis.—The sponge has the form of a greatly elongated, hollow tube, whose wall is composed of two distinct layers of about equal thickness. The outer (cortical) layer is provided with a very strongly developed skeleton of radiate spicules and contains the narrow, ramifying inhalant canals. The inner (chamber) layer is formed by elongated radial chambers arranged very regularly side by side. The skeleton of the chamber layer is very feebly developed; the normal subgastral triradiates are replaced by quadriradiates; the tubar skeleton is articulate, and composed of very abnormal sagittal triradiates whose paired rays are greatly reduced.

(For species see Part 3 of the present paper.)

GENUS VI.—*Ute* (Schmidt, *emend.*)

Diagnosis.—The ends of the elongated rádial chambers are covered over by a well developed cortex, consisting in great part of large oxeote spicules arranged parallel to the long axis of the sponge. The tubar skeleton is articulate or else composed entirely of the basal rays of subgastral triradiates.

(For examples see Part 3 of the present paper.)

* I propose these names for spicules lying beneath the dermal surface and with inwardly directed basal or apical rays as the case may be. Such spicules are of great importance for purposes of classification.

SUB-GENUS.—*Synute*, Dendy.

Diagnosis. — Sponge compound, consisting of many *Ute*-like individuals completely fused together and invested in a common cortex composed largely of huge oxeote spicules.

(For species see Part 3 of the present paper.)

GENUS VII.—*Utella*, nov. gen.

Diagnosis.—Flagellated chambers elongated, arranged radially around the central gastral cavity. There are no longitudinally arranged oxea in the dermal cortex, but a layer of oxeote spicules lies beneath and parallel to the gastral surface. The tubar skeleton is articulate.

I propose this genus for Hæckel's *Sycandra hystrix.** Schmidt's *Ute utriculus* (the *Sycandra utriculus* of Hæckel†) may perhaps also be included therein.

No Australian species are as yet known.

GENUS VIII.—*Anamixilla* (Poléjaeff, *emend.*)

Diagnosis.—Flagellated chambers elongated and radially arranged. There is no special tubar skeleton, the skeleton of the chamber layer consisting of large radiate spicules, arranged without regard to the direction of the chambers, and of the outwardly directed basal rays of subgastral triradiates.

(For species see Part 3 of the present paper.)

GENUS IX.—*Sycyssa*, Hæckel.

Diagnosis.—The flagellated chambers are elongated and arranged radially around the central gastral cavity. The skeleton consists exclusively of oxeote spicules.

The only known species of this genus is Hæckel's *Sycyssa huxleyi*,‡ from the Adriatic.

GENUS X.—*Leucandra* (Hæckel, *emend.*)

Diagnosis.—The flagellated chambers are spherical or sac-shaped, irregularly arranged and communicating with the

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* Die Kalkschwämme. Vol. II, p. 375. † *Loc. cit.*, p. 370.

‡ Loc. cit., p. 260.

gastral cavity, or main exhalant canals, by a more or less complicated canal-system. The skeleton of the chamber layer is irregular.

(For examples see Part 3 of the present paper.)

GENUS XI.—*Lelapia* (Gray, *emend.*)

Diagnosis.—Canal system unknown. Skeleton of gastral surface composed of ordinary radiates. Skeleton of dermal surface composed of triradiates, quadriradiates and minute oxea. Skeleton of the chamber layer composed of large, longitudinally arranged oxea, crossed at right angles by bundles of tuning-fork-shaped triradiates whose oral rays are directed towards the gastral cavity, while the basals point towards the dermal surface.

(For species see Part 3 of the present paper).

GENUS XII.—*Leucyssa*, Hæckel.

Diagnosis.—Flagellated chambers (presumably) spherical or ovoid, irregularly arranged. Skeleton composed solely of oxeote spicules.

No species of this remarkable genus are as yet recorded from Australian seas, the only examples being Hæckel's *Leucyssa spongilla*, *L. cretacea* and *L. incrustans.**

FAMILY 4.—HETEROPIDÆ.

There is a distinct and continuous dermal cortex covering over the chamber layer and pierced by inhalant pores. Subdermal sagittal triradiates are present. The flagellated chambers vary from elongated and radially arranged to spherical and irregularly scattered. An articulate tubar skeleton may or may not be present.

GENUS XIII.—*Grantessa* (von Lendenfeld, *emend.*)

Diagnosis.—The flagellated chambers are elongated and arranged radially around the central gastral cavity. The dermal cortex consists principally of triradiates and does not contain longitudinally disposed oxea.

(For examples see Part 3 of the present paper.)

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* Loc. cit., pp. 137, 138, 139.

GENUS XIV.—*Heteropia* (Carter, *emend.*)

Diagnosis.—The distal ends of the elongated radial chambers are covered over by a well-developed dermal cortex, consisting principally of large oxea arranged parallel to the long axis of the sponge.

I propose to retain this generic name for Carter's *Aphroceras ramosa,** which he observes belongs to his genus *Heteropia.* No species are yet known from Australia.

GENUS XV.—*Vosmaeropsis,* nov. gen.

Diagnosis.—Flagellated chambers spherical or sac-shaped, never truly radial. Dermal cortex composed principally of triradiates, without longitudinally disposed oxea.

(For species see Part 3 of the present paper.)

FAMILY 5.—AMPHORISCIDÆ.

There is a distinct and continuous dermal cortex covering over the chamber layer. Subdermal quadriradiates are present. The flagellated chambers vary from elongated and radially arranged to spherical and irregularly scattered.

GENUS XVI.—*Heteropegma* (Poléjaeff, *emend.*)

Diagnosis.—The flagellated chambers are elongated and arranged radially around the central gastral cavity. There is a vestigial tubar skeleton of minute radiates. The dermal cortex is very thick, composed principally of large triradiate spicules.

(For species see Part 3 of the present paper.)

GENUS XVII.—*Amphoriscus* (Hæckel, *emend.*)

Diagnosis.—The flagellated chambers are elongated and arranged radially around the central gastral cavity. The skeleton of the chamber layer is composed exclusively of the apical rays of subdermal and subgastral quadriradiates.

(For examples see Part 3 of the present paper.)

GENUS XVIII.—*Syculmis* (Hæckel, *emend.*)

Diagnosis.—The flagellated chambers are elongated and arranged radially around the central gastral cavity. The

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* Proc. Lit. Phil. Soc. Liverpool, Vol. XL, Appendix, 1886, p. 92.

skeleton of the chamber layer is composed of the apical rays of subdermal and subgastral quadriradiates. There is a root-tuft of oxea and anchoring quadriradiates.

The only known species of this remarkable genus is Hæckel's *Syculmis synapta,** from Bahia.

GENUS XIX.—*Leucilla* (Hæckel, *emend.*)

Diagnosis.—Flagellated chambers spherical or sac-shaped, never truly radial.

(For examples see Part 3 of the present paper.)

GENUS XX.—*Paraleucilla,* nov. gen.

Diagnosis.—Chambers spherical or sac-shaped (?). Beneath the dermal cortex a series of subdermal cavities supported by an outer and inner layer of quadriradiates whose apical rays cross each other in opposite directions. Beneath these comes the chamber layer, whose skeleton consists of irregularly arranged quadriradiates. Large, longitudinally arranged oxea occur between the triradiates of the dermal cortex.

(For species see Part 3 of the present paper.)

3. SYNOPSIS OF THE AUSTRALIAN SPECIES OF CALCAREA HETEROCŒLA.

1. *Leucascus simplex,* n. sp.

Sponge usually more or less flattened, cushion-shaped, spreading, with convex upper surface; sometimes becoming almost globular. Oscula irregularly scattered on the upper surface, one or several, varying in size, naked. Surface smooth. The largest specimen is a rather thin, ovoid, flattened crust, which, from its shape, appears to have grown on a crab's back; it is about 35 mm. long, 20 mm. broad, and only about 2 mm. thick in most parts; the other specimens, though smaller, are much thicker, one being nearly spherical. The surface is covered by a thin, pore-bearing dermal membrane.

* Die Kalkschwämme, Vol. II, p. 288.

The flagellated chambers (if one may use the term) are greatly elongated, tubular and copiously branched; their terminal branches end blindly beneath the dermal membrane. Their walls are thin and pierced by numerous prosopyles. There is no central gastral cavity but the chambers open into exhalant canals, devoid of collared cells, which converge towards the oscula. The scattered dermal pores lead into wide, irregular spaces between the tubular chambers.

The skeleton is extremely simple, consisting of small, regular triradiates, irregularly scattered in the walls of the chambers and exhalant canals, and in the dermal membrane. All the spicules are alike, except that some exhibit an incipient apical ray. The rays are straight, conical, fairly sharply pointed; measuring about 0·1 by 0·01 mm.

Localities.—Near Port Phillip Heads (Stations 1 and 5, coll. J. B. Wilson); Watson's Bay, Port Jackson (coll. T. Whitelegge).

2. *Leucascus clavatus*, n. sp.

The type specimen of this species is a sub-globular sponge about 14 mm. in maximum diameter, with a single rather wide osculum. It very closely resembles *L. simplex* in general appearance, canal system and skeleton, and the only point of distinction of any importance which I have been able to find consists in the presence in *L. clavatus* of large club-shaped oxea lying at right angles to and with the club-shaped extremity projecting slightly beyond the dermal surface. These spicules attain a length of about 0·7, and a diameter, in the thickest part, of about 0·1 mm. The outer end of the spicule is usually more or less rounded off and slightly curved, while the inner portion is straight and tapers gradually to a sharp point. The triradiates are like those of *L. simplex*, and of nearly the same size, perhaps a little larger on an average.

A second specimen is irregularly lobate, and differs from the type in its much denser texture, which is due to the stronger development of the mesoderm. It contains very numerous embryos, which fact may be associated with the strong development of the mesoderm.

Locality.—Near Port Phillip Heads (coll. J. B. Wilson).

3. *Sycetta primitiva*, Hæckel.

Sycetta primitiva, Hæckel. Die Kalkschwämme, Vol. II, p. 237.

Locality.—Bass Straits, Gulf of St. Vincent (Hæckel).

4. *Sycon coronatum*, Ellis and Solander, sp.

Spongia coronata, Ellis and Solander. Zoophytes, p. 190.
Grantia ciliata, auctorum.
Sycandra coronata, Hæckel. Die Kalkschwämme, Vol. II, p. 304.

Locality.—East coast of Australia (Hæckel. Also recorded from the Mediterranean, Atlantic and Pacific).

5. *Sycon carteri*, n. sp.

Colonial; consisting of very many small Sycon individuals united in a copiously branching, bushy mass; branching irregular. Sycon individuals about 5 mm. in length by 1·5 mm. in diameter; cylindrical; with minutely conulose surface and naked, terminal oscula.

Canal-system typical; chambers thimble-shaped, rather short, with freely projecting distal cones.

Skeleton arranged in typical manner. Spicules as follows:—(1) Gastral quadriradiates; sagittal; oral rays shorter and stouter than basal, slightly recurved, gradually sharp-pointed, measuring 0·11 × 0·007 mm.; basal ray rather more slender, straight, very gradually sharp-pointed, about 0·2 mm. long; apical ray variable, stout, more or less curved, often angulate, gradually sharp-pointed, about 0·077 mm. long. (2) Gastral triradiates; like the quadriradiates but without the apical ray. (3) Subgastral sagittal triradiates; oral rays extended almost in a line, gradually sharp-pointed, measuring about 0·06 × 0·007 mm.; basal ray very long (0·175 mm.), straight, gradually sharp-pointed, extending for more than half the length of the chamber and forming by itself about half of the articulate tubar skeleton. (4) Ordinary tubar triradiates; like the last but with shorter basal ray and oral angle diminishing towards the distal cone. (5) Oxea of the distal cones; rather short and stout, angulate, with shorter and stouter outer, and longer and slenderer inner segments; fairly sharp-pointed at both ends; measuring about 0·15 × 0·01 mm.

Locality.—St. Vincent's Gulf, S. Australia, (coll. Adelaide Museum).

6. *Sycon minutum*, n. sp.

Solitary; sessile, or with very short stalk; sub-cylindrical or sausage-shaped, with naked terminal osculum surrounded by a membranous extension of the wall of the gastral cavity. Texture characteristically soft and spongy; surface minutely conulose. Usually only about 5 or 6 mm. in height by 2 mm. in breadth.

Canal system typical; chambers rather short, thimble-shaped, often octagonal in transverse section, with low rounded distal cones; inhalant canals usually square in transverse section.

Skeleton arranged as usual. Spicules as follows:—(1) Gastral quadriradiates; facial rays straight, subequal in length, very long, slender and gradually sharp-pointed, measuring about 0·12 by 0·0035 mm.; oral angle somewhat smaller than the paired angles; apical ray short, relatively stout, slightly curved, sharp-pointed, about 0·03 mm. long. Towards the osculum these spicules become much more markedly sagittal. (2) Gastral triradiates; like the foregoing, but without apical ray. (3) Subgastral triradiates, not distinguishable in form from the ordinary tubar spicules. (4) Tubar triradiates; varying from sagittal, with very widely extended, slightly curved, oral rays, to sub-regular; rays long and slender, gradually sharp-pointed, the basal not much longer than the orals, measuring about 0·1 by 0·006 mm.; these spicules are rather irregularly arranged. (5) Oxea of the distal cones; not very numerous; long, slender, straight or very slightly curved; fusiform and gradually sharp-pointed at each end; measuring about 0·28 by 0·007 mm.; arranged in loose tufts which project obliquely upwards from the distal cones towards the osculum.

Locality.—Watson's Bay, Pt. Jackson (coll. T. Whitelegge).

7. *Sycon raphanus*, O. Schmidt.

Sycon raphanus, O. Schmidt. Spong. Adriat. Meer., p. 14.

Abundant in the collection. Solitary, usually about half an inch in height, with well developed stalk, markedly conulose surface and small oscular fringe. In spiculation I can find no tangible distinction between this common Victorian species and the European *S. raphanus* as described by Hæckel in "Die Kalkschwämme."

Localities.—Near Port Phillip Heads (Stations 1, 8, 14, and outside the Heads, coll. J. B. Wilson); King Island (coll. Professor Spencer). Hæckel also records the species from Bass Straits and the Gulf of St. Vincent.

8. *Sycon setosum*, O. Schmidt.

Sycon setosum, O. Schmidt. Spong. Adriat. Meer., p. 15.

I identify two specimens in the collection with this species. They differ from the typical *S. raphanus* in the more hairy surface, due to the greater length of the dermal oxea, and also in the elongation of the apical rays of the gastral quadriradiates. Probably it is merely a slight variety of *S. raphanus*. The species has hitherto only been recorded from the Mediterranean.

Locality.—Near Port Phillip Heads (Stations 6, 9, coll. J. B. Wilson).

9. *Sycon ensiferum*, n. sp.

Solitary, stipitate, closely resembling *S. raphanus;* with very markedly conulose surface and little or no oscular fringe. The two specimens are rather larger and especially stouter than most Australian specimens of *S. raphanus* which I have seen.

Canal-system typical; chambers of good length, terminating in low, rounded distal cones.

Skeleton arranged in typical manner. The species is distinguished by the following characters in its spiculation, which in general characters resembles that of *S. raphanus* closely:—(1) The apical rays of the gastral quadriradiates are very strongly developed, swelling out into long club-shaped form (sword-shaped in longitudinal section), but fairly sharply pointed and only very slightly curved, very much broader in the distal than in the proximal half. (2) The ordinary tubar radiates very frequently have a small apical ray developed. (3) The basal rays of many of the most distally situated tubar triradiates are very strongly bent outwards from the wall of the chamber, so as to curve over and protect the entrances to the inhalant canals. (4) The oxea at the distal ends of the chambers are of moderate length and thickness, straight or nearly so, symmetrical and fairly gradually sharp-pointed at each end.

Locality.—Near Port Phillip Heads (Station 9, coll. J. B. Wilson.)

10. *Sycon subhispidum*, Carter, sp.

Grantia subhispida, Carter. Annals and Magazine of National History, July 1886, p. 36.

This species, described by Mr. Carter from Mr. Wilson's collection, evidently belongs to the genus *Sycon*, but I have not been able to identify any of my specimens therewith.

Locality.—Near Port Phillip Heads (Carter).

11. *Sycon ramsayi*, von Lendenfeld, sp.

Sycandra ramsayi, von Lendenfeld. Proc. Linn. Soc., N.S.W., Vol. IX, p. 1097.

I have only seen specimens of this species from Port Jackson. Mr. Carter, however, records it amongst Mr. Wilson's sponges from Port Phillip. The gastral cavity is, according to my experience, widely dilated, and not comparatively small, as stated in the original description.

Localities.—Port Jackson (von Lendenfeld, &c.); near Port Phillip Heads (Carter).

12. *Sycon boomerang*,* n. sp.

Solitary, stipitate; of slightly compressed, ovoid shape, tapering gradually below to form the narrow stalk, which is about equal in length to the main body of the sponge; with a rather small, terminal, naked osculum. Total height of the specimen about 37 mm., greatest breadth 12·5 mm. The dermal surface is smooth and even, but with a characteristic porous appearance. The wall of the sponge is very thick and the gastral cavity correspondingly narrow.

The radial chambers are very long and narrow and branch repeatedly, the branches running parallel and becoming much narrower as they approach the dermal surface. The inhalant canals are correspondingly long and narrow, and their outer ends are covered over by a delicate pore-bearing membrane which stretches between the rounded distal ends of the chambers. The gastral cortex is thin. The skeleton is arranged in typical manner, the spiculation being as follows:—(1) Gastral quadriradiates; sagittal; with very long, slender, hastate basal ray, measuring about 0·2 × 0·007 mm., sometimes longer; paired rays about one-third to one-half the length of the basal ray and somewhat stouter, straight, conical, gradually sharp-

* So called from the shape of the apical rays of the gastral quadriradiates.

pointed; apical ray very strongly developed, gradually thickening for about two-thirds of its length, where it is extraordinarily stout, then bending sharply and tapering more suddenly to a sharp point, length about 0·155 mm., greatest thickness up to 0·028 mm. though generally less. (2) Gastral triradiates; sagittal or subregular, with long, slender, gradually sharp-pointed rays, the oral rays often somewhat curved. (3) Subgastral sagittal triradiates, not clearly differentiated from the ordinary tubar spicules. (4) Tubar triradiates; with very long, straight, slender, conical basal ray and shorter, widely extended, often slightly curved oral rays. In spicules taken from about the middle of the length of the chamber the basal ray measures about 0·17 by 0·07 mm., and the orals about 0·1 by 0·07 mm.; but there is a good deal of variation. In some of the tubar spicules a fairly well developed apical ray is found. In some of the most distal triradiates the basal ray, now much shortened, is curved outwards so as to lie in the pore-bearing membrane, which is also supported by small, scattered triradiates and oxeotes like those found at the distal ends of the chambers. (5) Oxea of the distal cones; short but fairly stout, more or less club-shaped, usually with the thick distal portion bent at an angle to the remainder; measuring about 0·08 by 0·008 mm.; these characteristic little spicules are arranged in dense tufts at the distal ends of the chambers.

Locality.—Near Port Phillip Heads (coll. J. B. Wilson).

13. *Sycon gelatinosum*, Blainville, sp.

Alcyoncellum gelatinosum, Blainville. Actinologie, p. 529.

Sycandra alcyoncellum, Hæckel. Die Kalkschwämme, Vol. 2, p. 333.

Sycandra arborea, Hæckel. Die Kalkschwämme, Vol. 2, p. 331.

This common Australian species is very variable in form, being either colonial (generally richly branched) or solitary, with the oscula sometimes naked and sometimes provided with a fringe of spicules. The shape of the dermal oxea also varies greatly, from club- or nail-shaped to sharply-pointed at each end. The extensive series of specimens in my collection, from various parts of Australia, shows that it is quite impossible to separate Hæckel's two species, *arborea* and *alcyoncellum*, from one another, and I revert to Blainville's original name, *gelatinosum*, for both.

Localities.—Port Jackson; Port Phillip; Bass Straits; St. Vincent's Gulf; west coast of Australia (various authors and collections; Hæckel also records the species from Java).

13A. *Sycon gelatinosum* var. *whiteleggii*, nov.

I propose to distinguish by the above name a very beautiful variety of the foregoing species found by Mr. T. Whitelegge at Watson's Bay, Port Jackson. There are nine specimens, all solitary and with a well-developed oscular fringe of long silky spicules. In addition to this oscular fringe, however, all have a beautiful frill or collar of long, silky spicules, projecting like a halo from the base of the oscular fringe and at right angles to the long axis of the sponge. In external form this variety closely resembles Hæckel's beautiful figure of *S. (Sycarium) elegans.* The dermal oxea are long and slender, and gradually sharp-pointed at each end, and the more distal tubar triradiates are greatly enlarged, with long and stout, but still straight basal rays. These peculiarities in spiculation are, however, found in some specimens of *S. gelatinosum*, from which the present variety cannot be sharply distinguished.

Locality.—Watson's Bay, Port Jackson (coll. T. Whitelegge).

14. *Sycon giganteum*, n. sp.

Solitary, with very short stalk or none at all. Tubular, greatly elongated, in parts more or less compressed, but not varying greatly in diameter throughout; with a single, wide, naked osculum. Both specimens are curved or bent. The largest is nearly 100 mm. in length by 14 mm. in breadth; the other is only a little shorter. The wall of the sponge is about 3 mm. in thickness. The dermal surface is in part quite smooth and in part tessellated.

The radial chambers are narrow and greatly elongated, they branch repeatedly and the branches run parallel with one another to the dermal surface. They communicate with the gastral cavity by long exhalant canals, from which they are separated by diaphragms. These exhalant canals appear like continuations of the chambers only without collared cells, they may unite together before opening on the gastral surface. The chambers are approximately circular in transverse section. The inhalant canals are irregular and very

narrow, opening on the dermal surface through narrow, irregular chinks between the tufts of oxea.

The skeleton is arranged as usual, the spiculation being as follows:—(1) Gastral quadriradiates; small, very irregularly and confusedly arranged, so as to form a dense though not very thick cortex; usually more or less strongly sagittal, but very variable in the proportions of the rays. The basal ray varies from two or three times the length of the orals to about the same length or even shorter; it is straight and conical. The oral rays are usually slightly curved towards one another, conical and sharp-pointed, averaging about 0·04 by 0·005 mm. at the base; apical ray conical, very slightly curved, sharply pointed, about 0·05 mm. long. (2) Subgastral sagittal spicules, indistinguishable. (3) Tubar triradiates, with rather short and stout, conical, sharp-pointed rays; the oral rays very widely extended, often nearly at right angles to the basal, nearly straight, averaging about 0·084 mm. by 0·009 mm. at the base; basal ray varying from about the same length to considerably longer than the orals, the disproportion being greatest at the distal ends of the chambers. (4) Tubar quadriradiates, differing from the foregoing in the development of a short, stout, curved and sharply pointed apical ray; abundant, especially towards the gastral surface, where the tubar skeleton becomes very irregular. (5) Oxea, short, straight or rather crooked, slender, tapering to a sharp point at the proximal end and with the distal end swollen out into an ovoid head, like that of a spermatozoon, length about 0·17, thickness below the head 0·007 mm., head nearly twice as thick. These spicules are arranged in very dense tufts at the distal ends of the chambers and their thickened ends form an almost continuous crust over the dermal surface of the sponge. The whole skeleton is very dense and compact, so that the texture of the sponge is very firm, as in *S. gelatinosum*, which it closely approaches in spiculation.

Locality.—St. Vincent's Gulf (coll. Adelaide Museum).

15. *Sycon compressum*, auctorum.

Grantia compressa, various authors (*e.g.*, Bowerbank).

Sycandra compressa, Hæckel. Die Kalkschwämme, Vol. II, p. 360.

This common European species is recorded from Australia both by von Lendenfeld and Carter, but I have never

myself seen specimens from Australian seas. Von Lendenfeld* states that all the specimens in Australian waters are cylindrical and must be referred to Hæckel's variety *lobata*, which he proposes to erect into a species under the name *Grantia lobata*. Carter† simply records *Grantia compressa* amongst Mr. Wilson's sponges, and *also* a tubular variety which he terms *fistulata*, and which is probably identical with von Lendenfeld's *lobata*.

I include the species in the genus *Sycon* on account of the tufts of oxea which crown the radial tubes. The dermal cortex is very thin.

Localities.—Port Jackson (von Lendenfeld); near Port Phillip Heads (Carter).

16. *Grantia labyrinthica*, Carter.

Teichonella labyrinthica, Carter. Annals and Magazine of Natural History, July 1878, p. 37.

Grantia labyrinthica, Carter. Annals and Magazine of Natural History, July 1886, p. 38.

I have already given a detailed account of the history and anatomy of this remarkable species in my memoir "On the Anatomy of *Grantia labyrinthica*, Carter, and the so-called Family Teichonidæ," published in Vol. XXXII, N.S., of the Quarterly Journal of Microscopical Science. The species appears to be fairly common near Port Phillip Heads, the largest specimens which I have seen measure no less than five inches across the top, a truly gigantic size for a single Sycon individual.

Localities.—Fremantle, W.A. (Carter); near Port Phillip Heads (Station 5 and outside the Heads, Carter and coll. J. B. Wilson).

17. *Grantia extusarticulata*, Carter, sp.

Hypograntia extusarticulata, Carter. Annals and Magazine of Natural History, July 1886, p. 43.

Solitary, sessile, sac-shaped, broadest below and tapering gradually to the terminal osculum, which is naked. The single specimen is markedly compressed, and measures 25 mm. in height and 11 mm. in greatest width. The wall of the sac is not much more than 1 mm. in thickness and the gastral cavity is correspondingly spacious. The dermal

* Proc. Linn. Soc., N.S.W. Vol. IX, p. 1106.

† Ann. and Mag. Nat. Hist. July 1886, p. 37.

surface is very smooth. The anatomy is very typical. The radial chambers are straight, cylindrical and only slightly branched, and extend from gastral to dermal cortex. The inhalant pores are irregularly scattered through the dermal cortex, which is well developed and about 0·07 mm. thick. The gastral cortex is of about the same thickness and is perforated by the short, wide exhalant canals, one coming from each chamber and separated from it by a constricted diaphragm.

The skeleton is arranged in typical manner, the spiculation being as follows:—(1) Gastral quadriradiates; sagittal, oral angle a little wider than the laterals; facial rays straight, conical, gradually sharp-pointed; basal ray about 0·2 by 0·01 mm.; oral rays 0·12 by 0·01 mm.; apical ray short, fairly stout, only moderately sharply-pointed, slightly curved, about 0·06 mm. long. (2) Gastral triradiates; similar to the foregoing, but with no apical ray. (3) Subgastral sagittal triradiates; strongly developed, with widely extended, slightly recurved, gradually sharp-pointed oral rays and very long, straight basal ray gradually tapering to a sharp point; oral rays about 0·15 by 0·014 mm.; basal ray about 0·35 by 0·014 mm. (4) Tubar triradiates; somewhat smaller than the foregoing but well developed, with straight or nearly straight rays, gradually sharp-pointed, the basal considerably longer than the other two. (5) Dermal triradiates; sagittal, very similar to the tubar triradiates but perhaps a little longer and placed horizontally in the dermal cortex. (6) Oxea of the dermal cortex; very small, straight, gradually sharp-pointed at the inner end and beautifully hastate or lance-pointed at the outer; about 0·045 by 0·005 mm.; arranged at right angles to the dermal surface. Occasionally a large oxeote spicule is found around the margin of the osculum, but these are extremely rare.

Mr. Carter's specimen, described from Mr. Wilson's collection, was "agglomerated." I have little doubt as to the specific identity of the two, but there are sufficient points of distinction between my specimen and Mr. Carter's original description to render a fresh description desirable.

Locality.—Near Pt. Phillip Heads (Carter; and Station 9, coll. J. B. Wilson).

18. *Grantia gracilis*, von Lendenfeld, sp.

Vosmaeria gracilis, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1111.

In canal system, so far as we can judge from the author's description, this species appears to resemble my *Grantia vosmaeri,* the radial chambers communicating with the gastral cavity by elongated exhalant canals.

Locality.—Port Jackson (von Lendenfeld).

19. *Grantia vosmaeri,* n. sp.

Specimen solitary, sessile (?), sac-shaped, tapering gradually above to the naked, terminal osculum; 15 mm. high and 7 mm. in greatest transverse diameter. Texture hard, dermal surface echinated by the large, projecting oxea. Wall of sac only about 1 mm. thick.

The dermal cortex is very strongly developed, about 0·08 mm. thick; the gastral cortex is two or three times as thick, but less dense and not so well-defined. The radial chambers are rather short and more or less branched. Their distal ends abut against the dermal cortex, while proximally they communicate with the gastral cavity by means of long, wide, exhalant canals, which penetrate the gastral cortex and may unite together before opening onto the gastral surface. The chambers are separated from the exhalant canals by constricted diaphragms. The inhalant pores take the form of irregular canals penetrating the dermal cortex.

Except for the unusual thickness of the cortex and the great size of the oxeote spicules the skeleton is arranged in the ordinary manner. The spiculation is as follows:—(1) Gastral quadriradiates; usually more or less sagittal, but very variable; rays straight or paired rays slightly curved, stout, conical and gradually sharp-pointed; size very variable; paired rays averaging, say, about 0·2 by 0·025 mm.; basal ray about the same thickness and usually somewhat longer; apical ray thorn-like, short, stout, conical, usually slightly curved, finely pointed, about 0·07 mm. long, projecting into the gastral cavity and exhalant canals. (2) Gastral triradiates; usually like the foregoing but without the apical ray; towards the osculum, however, they become much more strongly and regularly sagittal, the widespread, slightly recurved oral rays being much longer and stouter than the basal ray; amongst these suboscular spicules quadriradiates are very rare. (3) Subgastral sagittal triradiates; indistinguishable from the remainder of the tubar skeleton, which merges somewhat gradually into the gastral cortex. (4) Tubar triradiates;

strongly sagittal; with widely extended, short, straight, conical and gradually sharp-pointed oral rays, and much longer, straight, gradually sharp-pointed basal ray; oral rays about 0·1 by 0·015 mm.; basal ray about 0·28 by 0·015 mm. (5) Triradiates of the dermal cortex; usually slightly sagittal but nearly regular; rays stout, straight or slightly curved, conical, gradually sharp-pointed; about 0·24 by 0·028 mm.; arranged in several layers parallel with the dermal surface. (6) Oxea; very large, stout, fusiform, usually gently curved, gradually sharp-pointed at each end; varying in size up to about 1·8 by 0·07 mm. The outer ends of these spicules project far beyond the dermal surface, while their inner ends extend through the chamber layer into the gastral cortex.

Locality.—Watson's Bay, Port Jackson (coll. T. Whitelegge).

20. *Grantia (?) infrequens*, Carter, sp.

Hypograntia infrequens, Carter. Annals and Magazine of Natural History, July 1886, p. 39.

The chief peculiarities of this species appear to be the presence of a very strong dermal cortex and the fact that the tubar skeleton is made up entirely of the basal rays of subgastral sagittal triradiates. I have not seen the species myself, and Mr. Carter apparently had only a single small specimen, collected by Mr. Wilson. I include it provisionally in the genus *Grantia*.

Locality.—Near Port Phillip Heads (Carter).

21. *Grantia (?) lævigata*, Hæckel, sp.

Sycortis lævigata, Hæckel. Die Kalkschwämme, Vol. II, p. 285.

In his description Hæckel distinctly states that in the case of the tubar triradiates the basal ray is always directed centrifugally outwards, while in the dermal triradiates it lies parallel to the long axis of the sponge and points to the aboral pole. No mention is made in the text of any subdermal sagittal triradiates with inwardly directed basal ray, but in the figure (Plate 49, Fig. 3) such appear to be present. Hence if the figure be correct we should have to place the species in the genus *Grantessa*, but the evidence is hardly strong enough to justify us in so doing at present.

Locality.—Gulf of St. Vincent (Hæckel).

22. *Grantiopsis cylindrica*, n. sp.

Sponge forming long, cylindrical tubes, which may branch, with single, terminal, slightly constricted, almost naked oscula. Surface not hispid but slightly roughened by the large triradiate spicules of the cortex. The largest tube in the collection is unbranched and slightly crooked, 57 mm. long and with a nearly uniform diameter of 5 mm.

The wall of the tube is about 1 mm. in thickness, and is divided into two sharply defined concentric layers of about equal thickness. The outer of these layers forms a firm cortex with a very strongly developed skeleton. The inner layer is soft and spongy, consisting almost entirely of the radial chambers, which have but a feebly developed tubar skeleton.

The inhalant pores, scattered in groups over the dermal surface, lead into very sharply defined, wide inhalant canals, which penetrate the cortex, uniting into larger trunks which conduct the water to the ordinary "intercanals" between the radial chambers.

The radial chambers are arranged side by side with great regularity. Each is a straight, wide, unbranched (or very slightly branched) tube, extending completely through the chamber layer. In cross section they vary from nearly square to nearly circular. Each opens directly and separately into the gastral cavity, the gastral cortex being so thin that no special exhalant canals are required. Each is provided at its proximal end with a membranous diaphragm, which, in the spirit specimen, almost closes the opening.

The arrangement of the skeleton is a slight modification of the *Grantia* type, but the spiculation is very peculiar, as follows:—(1) Gastral quadriradiates; slightly sagittal, with small facial and enormous apical rays; the oral angle is rather wider than the lateral angles, but there is not much difference in the length of the facial rays, which are nearly straight (the orals may be slightly curved), fairly stout, conical and gradually sharp-pointed, about 0·056 by 0·007 mm. The apical ray is slightly curved, very stout, sword-shaped in optical section, thickest in about the middle, gradually sharp-pointed, about 0·14 by 0·014 mm. These apical rays thickly echinate the gastral surface. (2) Subgastral quadriradiates; strongly sagittal; the oral rays very widely extended and parallel to the gastral surface; the basal ray extending centrifugally towards the dermal surface through

about half the thickness of the chamber layer; the apical ray projecting into the gastral cavity, almost in a line with the basal ray. The basal ray is long, straight, and gradually sharp-pointed, about 0·28 by 0·01 mm.; the oral rays are short, straight, conical and gradually sharp-pointed, about 0·056 by 0·008 mm.; the apical ray is slender, conical, elongated, slightly curved and finely pointed, about 0·09 by 0·007 mm. (3) Tubar triradiates; consisting almost entirely of the strongly developed, centrifugally directed basal ray, which is straight, fusiform, gradually sharp-pointed at the distal end, and at the proximal end provided with a pair of minute, widely divergent, conical teeth, which represent the extremely reduced oral rays. The basal ray measures about 0·3 by 0·008 mm., while the teeth representing the oral rays are only about 0·003 mm. in length. The entire tubar skeleton is made up of these spicules and the basal rays of the subgastral quadriradiates, arranged usually in single series but with overlapping ends, each series comprising only about three spicules. (4) Triradiates of the dermal cortex; very large and stout and regularly sagittal, the oral angle being very considerably wider than the paired angles; all the rays are straight, conical and gradually sharp-pointed, the oral rays measuring about 0·54 by 0·07 mm., and the basal ray somewhat shorter and slenderer. These spicules are arranged in many layers, parallel to the dermal surface and extending through the entire thickness of the cortex. (5) Dermal oxea; short, slender, slightly crooked, sharply pointed at each end, about 0·1 by 0·006 mm. These spicules occur in large numbers on the dermal surface, projecting at right angles from the outermost portion of the cortex. (6) Oxea of the oscular fringe; long, straight and slender, gradually sharp-pointed at each end though hastate at the outer end. These spicules form a kind of vertical palisade inside the margin of the osculum, their outer ends projecting to form a feebly developed oscular fringe. (7) Oscular triradiates: closely resembling the remarkable tubar triradiates, but with the oral rays not quite so much reduced. These spicules occur mixed with the inserted portions of the oscular oxea, and assist the latter in forming a dense palisade; the paired rays are directed towards the osculum, and no part of the spicule projects freely like the oxea do.

This sponge is decidedly the gem of Mr. Wilson's collection. The exquisite symmetry of the skeleton and canal-system, combined with the remarkable spiculation, render it one of

the most beautiful and interesting sponges which I have ever seen, although the external form is not particularly attractive.

Locality.—Near Port Phillip Heads (coll. J. B. Wilson).

23. *Ute syconoides*, Carter, sp.

Aphroceras syconoides, Carter. Annals and Magazine of Natural History, August 1886, p. 135.

I identify with this species a single specimen collected by Mr. Wilson and a number of very beautiful examples sent to me from Port Jackson by Mr. T. Whitelegge. As pointed out by Mr. Carter, the species closely resembles Schmidt's *Ute glabra*, having the same characteristic silvery sheen on the surface, due to the presence of the huge, longitudinally disposed oxea. The Port Jackson specimens are shortly stipitate and one of them consists of two individuals united below for about half their length, or one might regard it as a branched individual.

Localities.—Near Port Phillip Heads (Carter, and Station 14, coll. J. B. Wilson); Watson's Bay, Port Jackson (coll. T. Whitelegge).

24. *Ute argentea*, Poléjaeff.

Ute argentea, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 43.

This species is also very similar to Schmidt's *Ute glabra*. Although the skeleton is, as Poléjaeff points out, "inarticulate," there are no subdermal sagittal triradiates with inwardly directed basal ray. From personal examination of Poléjaeff's type I believe this species to be quite distinct from *Ute syconoides*, the latter differing, amongst other things, in its much longer radial chambers, with many-jointed tubar skeleton, and in the much slenderer and less densely packed longitudinal oxea.

Locality.—Off Twofold Bay (Poléjaeff).

25. *Ute spiculosa*, n. sp.

Sponge colonial, consisting of a number of individuals (about twenty in the specimen under examination) united together by their bases so as to form a spreading colony. The individuals composing the colony are sessile, ovoid, narrowing above to the small terminal osculum, which has

a very inconspicuous fringe; they attain a height of about 15 mm. and a maximum diameter of about 5 mm. The texture is dense and firm, and the surface is roughened by the projecting ends of some of the large oxea.

The gastral cavity is narrow and cylindrical, occupying only about one-third of the total diameter of the sponge. The flagellated chambers are long and narrow and more or less radially arranged with regard to the central gastral cavity; they do not extend nearly through the entire thickness of the sponge wall, and they communicate with the gastral cavity through long, sometimes branched exhalant canals. The inhalant canal system consists of scattered pores on the dermal surface leading into elongated canals which lead down between the chambers, but the typical syconoid arrangement of the canal system is greatly obscured by the strong development of the mesoderm and the dense, irregular skeleton. There is a very thick, dense cortex on both dermal and gastral surfaces.

The skeleton of the gastral cortex consists of a densely felted mass of irregularly arranged triradiates, mostly lying parallel to the gastral surface. These spicules are sagittal, with fairly stout, straight, conical and gradually sharp-pointed rays; the oral rays are longer than the basal and the oral angle wider than the other two; oral rays about 0·18 mm. by 0·02 mm., basal about 0·12 mm. by 0·016 mm. The skeleton of the chamber layer is dense and irregular, but shows traces of the articulate tubar arrangement in the usually centrifugal direction of the basal rays of the triradiates. These spicules are smaller than those of the gastral cortex, and of different shape; there is not much difference in the length of the rays, though the basal may be slightly longer or shorter than the others; all the rays are fairly stout, conical and gradually sharp-pointed; the basal is straight but the orals are more or less curved towards one another; dimensions of rays about 0·12 by 0·016 mm.

The skeleton of the dermal cortex consists of a dense, confused mass of triradiates, resembling those of the chamber layer but becoming markedly smaller towards the outside, where they lie parallel to the surface; amongst which are found oxea of two kinds:—(1) Very large, stout, fusiform, slightly curved and sharply pointed at each end; measuring about 1·8 mm. by 0·1 mm., and arranged parallel to the long axis of the sponge, with the upper end often

slightly projecting. (2) Small, long and slender, nearly straight, gradually sharp-pointed at the inner end and usually more or less hastate or lance-pointed at the outer; measuring about 0·24 by 0·008 mm. These spicules occur in the outermost portion of the cortex, and their outer ends project well beyond and more or less at right angles to the dermal surface. A number of similar but longer spicules inserted around the inside of the osculum form a dense but not prominent oscular fringe.

Locality.—Watson's Bay, Pt. Jackson (coll. T. Whitelegge).

26. *Ute spenceri*, n. sp.

Sponge solitary, sessile, globular or sub-spherical, with correspondingly dilated gastral cavity and narrow, naked osculum. The texture is firm and harsh to the touch, the dermal surface being rather uneven and slightly roughened by the projecting apices of some of the large oxea, but not hispid. Diameter of entire sponge about 11 mm.; thickness of wall about 2·5 mm. The dermal cortex is very thick, occupying more than one-third of the entire thickness of the wall.

The inhalant pores, scattered over the surface of the sponge, lead into wide, irregular, sub-dermal cavities, lying in the cortex, from which narrow inhalant canals lead down between the radial chambers. The radial chambers are arranged with considerable regularity parallel to one another. They are long and narrow (about 1·0 mm. by 0·14 mm.), and at their distal ends they branch in a curiously irregular manner, the branches sometimes penetrating for some little distance into the dermal cortex. The proximal ends of the chambers are all situate about at the same level, which is some little distance from the gastral cavity and even from the gastral cortex, which latter, though dense, is very thin as compared with the dermal cortex. Hence we find a number of rather short, cylindrical, radially-arranged exhalant canals, which look like continuations of the radial chambers without the collared cells, and which may unite together in groups before opening on the gastral surface. The radial chambers are separated from the exhalant canals by well-marked diaphragms.

The skeleton is very dense and very complicated and consists of the following parts:—(1) Quadriradiates of the gastral cortex; sagittal, with straight, conical, gradually sharp-pointed facial rays; the oral angle is wider than the

paired angles and the basal ray may be either longer or shorter than the other two, which measure, say, about 0·09 by 0·008 mm.; the apical ray is well developed, conical, gradually sharp-pointed, slightly curved, and nearly as long and thick as the oral rays. These spicules form such a dense feltwork that it is difficult to make out the details of individual form *in situ*, while the projecting apical rays thickly echinate the gastral cavity. (2) Quadriradiates of the exhalant canals; these are extremely characteristic and peculiar spicules; the basal ray is reduced to a mere rounded tubercle, while the oral and apical rays are long, straight and very slender, and finely pointed; the oral rays diverge at an angle of about 120° and the apical comes off between them and appears to lie nearly in the same plane; the oral rays measure about 0·08 by 0·0027 mm., though occasionally stouter, and the apical ray is about one-third as long; these spicules are found around the exhalant canals, with the apical ray projecting into the cavity. A few larger and stouter quadriradiates, with normal basal ray, also occur around the exhalant canals. (3) Inner sagittal triradiates; under this term we may perhaps, in this species, include all those triradiates which lie in the zone between the gastral cortex and the commencement of the flagellated chambers, although they lie at varying depths beneath the gastral cortex. The oral rays are straight or nearly so, conical and gradually sharp-pointed, about 0·09 by 0·0085 mm.; the basal ray is long, straight, conical and gradually sharp-pointed, measuring about 0·16 by 0·0085 mm.; the oral angle is wider than the paired angles. (4) Tubar triradiates; very similar to the foregoing but the basal ray gradually diminishes in length towards the dermal cortex. These spicules form an articulate tubar skeleton of many joints, which is continued, as already indicated, within the inner limits of the chamber layer to the gastral cortex, while towards the outside it becomes irregular and gradually passes into the skeleton of the dermal cortex. (5) Triradiates of the dermal cortex; slightly sagittal or sub-regular, mostly larger and stouter than the tubar triradiates, with conical, sharp-pointed rays measuring about 0·16 by 0·02 mm., but very variable; towards the outside they lie parallel to the dermal surface, but otherwise they are very irregularly arranged. (6) Large oxea of the dermal cortex; fusiform, slightly curved, gradually sharp-pointed at each end; measuring about 1·4 by 0·1 mm., but sometimes more or

less. These spicules are imbedded in large numbers in the dermal cortex at various levels; they mostly lie more or less parallel to the long axis of the sponge, but there is a good deal of irregularity in their arrangement and not infrequently one end of the spicule projects slightly beyond the dermal surface. (7) Minute oxea of the dermal surface; short and slender, usually slightly curved; the inner end gradually tapering to a fine point, the outer end thicker, more or less hastate, minutely toothed or roughened. These spicules measure only about 0·04 by 0·003 mm.; they occur in large numbers on the dermal surface. (8) Minute oxea of the gastral surface; similar to the foregoing but not so numerous.

One of the two specimens in the collection was attached to a crab's back, which it completely covered like a thick crust; it resembled a specimen cut in half longitudinally, with the concave gastral surface turned towards the crab's back. Hence, as the gastral cavity was no longer an enclosed space, there was no osculum in the ordinary sense of the word. The crab, of course, occupied the gastral cavity, and the exhalant canals of the flagellated chambers must have discharged their contents on to the crab's back. One often finds sponges growing on crab's backs, but I never before saw a case in which the essential form of the sponge was so strangely modified in accordance with this habit. Had it not been for the presence of the other and normal specimen in the collection I should have been inclined to regard this strange modification in form as of at least specific value. The species, is, however, so well characterised by spiculation, &c., that there can be no doubt as to the identity of the two specimens.

I have much pleasure in dedicating this remarkable species to Professor W. Baldwin Spencer.

Locality.—Watson's Bay, Port Jackson (coll. T. Whitelegge).

27. *Synute pulchella*, Dendy.

Synute pulchella, Dendy. Proceedings of the Royal Society of Victoria, Vol. IV (New Series), p. 1.

I have nothing to add to my description of this remarkable sponge until such time as I may be able to publish illustrations of its anatomy.

Locality.—Near Port Phillip Heads (Dendy).

28. *Anamixilla torresi*, Poléjaeff.

Anamixilla torresi, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 50.

I have seen no specimen of this sponge except a portion of the type from the British Museum.

Locality.—Torres Straits (Poléjaeff).

29. *Leucandra australiensis*, Carter, sp.

Leuconia fistulosa, var. *australiensis*, Carter. Annals and Magazine of Natural History, August 1886, p. 127.

There is one specimen in the collection, belonging to the National Museum, which closely resembles in external characters and spiculation that described by Mr. Carter. The slenderness of the radiate spicules gives to the sponge a soft and yielding texture, while the dermal surface is densely hispid from the long, slender, projecting oxea. At first sight the specimen looks like a large example of *Grantessa hirsuta*, but it differs markedly in the arrangement of the canal system and in the absence of the subdermal sagittal triradiates. The chambers are large and irregularly sac-shaped, averaging say about 0·3 by 0·1 mm. (but very variable); not arranged radially around the central gastral cavity of the sponge, but around wide exhalant canals which penetrate the thickness of the wall of the sponge and are, like the gastral cavity itself, echinated by the apical rays of quadriradiate spicules.

Locality.—Near Port Phillip Heads (Carter, and Station 14, coll. J. B. Wilson).

30. *Leucandra alcicornis*, Gray, sp.

Aphroceras alcicornis, Gray. Proceedings of the Zoological Society of London, 1858, p. 114.

Leucandra alcicornis, Hæckel. Die Kalkschwämme, Vol. II, p. 184.

I have not yet had an opportunity of examining this widely distributed and very remarkable species.

Locality.—Bass Straits (Hæckel). Also recorded from various localities in the Pacific and Indian Oceans and from the Cape (*vide* Hæckel).

31. *Leucandra cataphracta*, Hæckel.

Leucandra cataphracta, Hæckel. Die Kalkschwämme, Vol. II, p. 203.

Leucandra cataphracta, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1129.

I am indebted to Mr. T. Whitelegge for a considerable number of fine specimens of this sponge from Watson's Bay, Port Jackson. Neither Hæckel nor von Lendenfeld have described the flagellated chambers, which are small, approximately spherical and scattered abundantly in the thick wall; measuring about 0·09 mm. in diameter.

Localities.—Port Jackson (Hæckel, von Lendenfeld, &c.); Port Denison (von Lendenfeld).

32. *Leucandra typica*, Poléjaeff, sp.

Leuconia typica, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 56.

Leucandra typica, von Lendenfeld. Proceeding of the Linnean Society of New South Wales, Vol. IX, p. 1130.

Locality.—Port Jackson (von Lendenfeld. Recorded by Poléjaeff from the Bermuda Islands).

33. *Leucandra meandrina*, von Lendenfeld.

Leucandra meandrina, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1128.

I identify with this species a somewhat massive but not large specimen collected by Mr. Wilson, which seems to agree closely with a fragment of the type from the British Museum, but the species is by no means an easy one to characterise.

The chambers are approximately spherical and about 0·09 mm. in diameter.

Localities.—Port Jackson (von Lendenfeld); near Port Phillip Heads (coll. J. B. Wilson).

34. *Leucandra vaginata*, von Lendenfeld.

Leucandra vaginata, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1133.

Locality.—Port Jackson (von Lendenfeld).

35. *Leucandra conica*, von Lendenfeld.

Leucandra conica, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1126.

Locality.—Port Jackson (von Lendenfeld).

36. *Leucandra hispida*, Carter, sp.

Leuconia hispida, Carter. Annals and Magazine of Natural History, August 1886, p. 128.

This species is abundant in the collection. It is distinguished by its elongated cylindrical form, hispid surface, and the long-rayed, slender triradiates of the main skeleton. All the specimens are solitary and sessile, of moderate size and with a well-developed oscular fringe. The large oxea of the dermal surface are long and comparatively slender, slightly curved. The flagellated chambers are approximately spherical and average about 0·09 mm. in diameter.

Mr. Carter appears to have had only a single specimen (collected by Mr. Wilson), which was exceptionally short and "conoglobular;" I judge from his description and manuscript illustrations of the spiculation that it is specifically identical with the specimens described above.

Localities.—Near Port Phillip Heads (Carter, and Stations 6, 10, 14, coll. J. B. Wilson); Port Jackson (coll. Professor Spencer).

37. *Leucandra echinata*, Carter, sp.

Leuconia echinata, Carter. Annals and Magazine of Natural History, August 1886, p. 129.

This species is abundant in the collection. The sponge usually has the form of a rather small, ovoid, sessile, thick-walled individual, with terminal fringed osculum and coarsely echinated dermal surface. The species exhibits a good deal of variation in spiculation, especially in the size of the irregularly arranged triradiates of the main skeleton, which are often very much larger than those of the dermal cortex. The other forms of spicule present are gastral quadriradiates, large dermal oxea (echinating the surface), and long, slender, hair-like oxea of the oscular fringe. The flagellated chambers are approximately spherical and densely scattered throughout the thickness of the wall; they measure about 0·09 mm. in diameter.

Locality.—Near Port Phillip Heads (Carter, and Stations 1, 9, 10 and outside the Heads, coll. J. B. Wilson); Watson's Bay, Port Jackson (coll. T. Whitelegge).

38. *Leucandra multifida*, Carter, sp.

Leuconia multifida, Carter. Annals and Magazine of Natural History, August 1886, p. 141.

Locality.—Near Port Phillip Heads (Carter).

39. *Leucandra lobata*, Carter, sp.

Leuconia lobata, Carter. Annals and Magazine of Natural History, August 1886, p. 143.

Locality.—Near Port Phillip Heads (Carter).

40. *Leucandra compacta*, Carter, sp.

Leuconia compacta, Carter. Annals and Magazine of Natural History, August 1886, p. 144.

Locality.—Near Port Phillip Heads (Carter).

41. *Leucandra phillipensis* n. sp.

The single specimen in the collection is a solitary, sessile, irregularly sac-shaped sponge, with a constricted terminal osculum provided with a feebly developed oscular fringe. The outer surface of the sponge is slightly hispid and the wall of the sponge is rather thin, enclosing a wide gastral cavity. The height of the sponge is about 40 mm., the greatest width 20 mm., and the thickness of the wall nearly 3 mm. There is a very thin dermal and gastral cortex. The canal-system is very typical; thickly scattered groups of dermal pores lead into wide, more or less lacunar inhalant canals, which penetrate deep into the substance of the wall. The exhalant canals are also wide and deep and unite together in groups before opening into the gastral cavity. Between these wide inhalant and exhalant canals the flagellated chambers are thickly scattered; these are generally more or less ovoid in shape but only about 0·14 mm. in longer diameter.

The skeleton is rather weak owing to the prevailing slenderness of the spicule-rays, the spiculation being as follows:—(1) Gastral quadriradiates; usually more or less sagittal; with very long, slender, straight or nearly straight, sharp-pointed facial rays; the oral angle wider than the paired angles and the oral rays somewhat longer than the basal; oral rays about 0·4 by 0·01 mm.; basal ray about 0·3 by 0·01 mm. The apical ray is straight or slightly curved, conical and finely pointed, measuring about 0·16 by 0·01 mm. These spicules are very abundant and form a thin gastral cortex, the apical rays projecting into the gastral cavity in large numbers. The walls of the larger exhalant canals are also provided with very similar spicules. Near the osculum the gastral spicules become much more strongly sagittal and

the apical ray is often absent. (2) Triradiates of the main skeleton; varying from nearly regular to slightly sagittal; with very long, slender, straight or slightly curved rays, sharply pointed and measuring about 0·33 by 0·016 mm. These spicules are very irregularly arranged but many of them have one ray pointing centrifugally towards the dermal surface. In many of them a small apical ray is developed. (3) Triradiates of the dermal surface; similar to the foregoing but decidedly smaller; arranged parallel to the surface to form a thin dermal cortex. (4) Large dermal oxea; rather slender, fusiform, symmetrical, very slightly curved, gradually sharp-pointed at each end; measuring about 1·4 by 0·03 mm.; occasionally however they are much larger and they may then have a hastately pointed inner end. These spicules are scattered singly and irregularly at right angles to the dermal surface, with the outer end projecting for a short distance. (5) Long, fine, hair-like oxea; these are arranged in loose, irregular, scattered bundles between the large oxea and they also form the feebly developed oscular fringe.

Locality.—Near Port Phillip Heads (coll. J. B. Wilson).

42. *Leucandra gladiator*, n. sp.

The single specimen in the collection forms an extremely irregular, contorted crust, with a number of deeply convex surfaces, bordered by prominent margins, as if it had grown over some irregularly cylindrical body. A few small oscula are irregularly scattered over the convex upper surface. The surface is slightly hispid, the hispid character becoming much more strongly developed at the margins of the crust. The specimen has been broken, but it must have been about 50 mm. in greatest diameter. The growth has been extremely irregular, and it has enclosed various foreign objects. The texture is coarse and fragile. The dermal cortex is strong, but not very thick.

The canal-system is difficult to work out in detail, owing to the strong development of the skeleton, which renders section-cutting very difficult. There is no large, central, gastral cavity, but a number of tolerably wide exhalant canals converge towards each osculum. The flagellated chambers are irregularly scattered, approximately spherical, and about 0·09 mm. in diameter.

The skeleton is composed of the following spicules:—(1) Gastral quadriradiates; minute, cruciform or dagger-shaped;

the apical ray long, slender, straight and gradually sharp-pointed, nearly in a line with the basal ray; the facial rays short, stout, conical and sharp-pointed, the basal rather longer than the other two and often slightly crooked, the orals being straight; basal ray about 0·03 by 0·007 mm.; orals 0·02 by 0·007 mm.; apical 0·08 (or less) by 0·006 mm. These spicules are found in the walls of the larger exhalant canals, but they are not very abundant. (2) Enormous sub-regular or irregular triradiates, with conical, gradually sharp-pointed rays which measure, when fully developed, about 1·8 by 0·16 mm. These spicules form the bulk of the skeleton and are irregularly and abundantly scattered throughout the thickness of the sponge; they vary considerably in size. (3) Small, straight oxea, of hair-like fineness and up to about 0·1 mm. in length; scattered through the interior of the sponge, either separately or in dense sheaves (trichodragmata). (4) Triradiates of the dermal cortex; strongly sagittal, with long, nearly straight, very widely extended, gradually sharp-pointed oral rays, and much shorter, straight, gradually sharp-pointed basal ray; these spicules form a dense feltwork, they are quite irregularly arranged, except that they all lie parallel to the dermal surface. They vary greatly in size, the oral rays, which are extended almost in a line, measuring up to about 0·65 by 0·036 mm., with the basal about 0·3 by 0·036 mm. (5) Dermal oxea; straight, slender, gradually sharp-pointed at each end. In most parts of the surface these spicules are comparatively few in number, projecting at right angles from the dermal cortex and measuring only about 0·4 by 0·01 mm. They vary greatly in size, however, and around the margins of the sponge they become very greatly elongated, forming a thick, dense fringe.

This very remarkable species is obviously very closely related to the European *Leucandra nivea*, as described by Hæckel in "Die Kalkschwämme"; in both we find colossal triradiates, smaller dermal triradiates, dagger-shaped quadriradiates and trichodragmata (which are extremely rare in calcareous sponges), and in both we meet with the characteristic encrusting habit. There are, however, certain marked differences in spiculation, as in the shape of the dermal triradiates and of the dagger-shaped quadradiates, and especially in the presence in *L. gladiator* of the projecting dermal oxea, which seem to be entirely wanting in *L. nivea*.

It is important to notice that Mr. Carter's *Leuconia nivea* var. *australiensis* appears to be totally distinct both from the true *Leucandra nivea* and from *L. gladiator*. It is curious that Mr. Carter should have chosen this name for one of Mr. Wilson's sponges and that later on Mr. Wilson should have obtained from the same locality another species which really is very closely related to the remarkable *Leucandra nivea*.

Locality.—Outside Port Phillip Heads (coll. J. B. Wilson).

43. *Leucandra carteri*, n. sp.

Leucaltis floridana, var. *australiensis*, Carter. Annals and Magazine of Natural History, August 1886. p. 145.

This species appears, from Mr. Carter's description, to be a large, massive *Leucandra*, resembling *L. microraphis* in form but distinguished by the presence of minute oxea on the surface. As the name *australiensis* is already occupied in the genus I propose to call the species *Leucandra carteri*.

Locality.—Near Port Phillip Heads (Carter).

44. *Leucandra schulzei*, Poléjaeff, sp.

Eilhardia schulzei, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 70.

Localities.—Off Pt. Jackson and Twofold Bay (Poléjaeff).

45. *Leucandra loricata*, Poléjaeff, sp.

Leuconia loricata, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 63.

Leucortis loricata, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1123.

Locality.—Off Port Jackson (Poléjaeff).

46. *Leucandra pulvinar*, Hæckel, sp.

Leucortis pulvinar, Hæckel. Die Kalkschwämme, Vol. II, p. 162.

This species ranges, according to Hæckel, from the Red Sea to the west coast of Australia. I have not yet met with it.

Locality.—West coast of Australia (Hæckel. Also recorded from the Red Sea and various parts of the Indian Ocean).

47. *Leucandra helena*, von Lendenfeld, sp.

Leucaltis helena, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1119.

Locality.—Port Jackson (von Lendenfeld).

48. *Leucandra pumila*, Bowerbank, sp.

Leuconia pumila, Bowerbank. Monograph of British Sponges, Vol. 2, p. 41.

Leucaltis pumila, Hæckel. Die Kalkschwämme, Vol. 2, p. 148.

Locality.—Bass Straits (Hæckel. Also recorded from various localities in the Atlantic Ocean, *vide* Bowerbank and Hæckel).

49. *Leucandra bathybia*, Hæckel, sp.

Leucaltis bathybia, Hæckel. Die Kalkschwämme, Vol. 2, p. 156.

Leucaltis bathybia var. *australiensis*, Ridley. Zool. Coll. H.M.S. "Alert," British Museum, p. 482.

Leucaltis bathybia, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1121.

Locality.—Port Jackson (Ridley. Recorded by Hæckel from the Red Sea).

50. *Leucandra pandora*, Hæckel, sp.

Leucetta pandora, Hæckel. Die Kalkschwämme, Vol. 2, p. 127.

Localities.—Bass Straits and Gulf of St. Vincent (Hæckel).

51. *Leucandra microraphis*, Hæckel, sp.

Leucetta microraphis, Hæckel. Die Kalkschwämme, Vol. 2, p. 119 (=*Leucetta primigenia* var. *microraphis*).

Leucetta microraphis, von Lendenfeld, Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1117.

Leuconia dura, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 65.

I identify with this species a number of large specimens of very irregular external form. They are sometimes compressed, sometimes massive and sometimes sac-shaped, with thick walls; usually with wide naked oscula and large

exhalant canals. The texture is very coarse, hard and dense; the surface is irregular, and often characteristically ridged; frequently the huge triradiate spicules can be seen with the naked eye on the dermal surface. Some specimens have a few quadriradiate spicules, while in others I cannot find any.

Some of the specimens measure four or five inches in their longest diameter, and one was remarkable from having been of a green colour in life, probably due to symbiotic algæ.

The flagellated chambers are approximately spherical; thickly scattered through the sponge, and about 0·12 mm. in diameter. In some specimens the mesoderm around the chambers is very strongly developed, giving to the sponge a very dense texture. The inhalant pores are scattered thickly over the dermal surface, at any rate in parts.

The skeleton is dense and very irregular, consisting of scattered triradiates of two very different sizes, rather small and enormously large, the former being most abundant.

I consider Poléjaeff's *Leuconia dura* to be identical with this species, because I do not think the presence of sagittal spicules in the neighbourhood of the osculum is a specific character, as it is of such extremely general occurrence.

Localities.—Near Port Phillip Heads (Stations 1 and 9 and outside the Heads, coll. J. B. Wilson); Torres Straits (Ridley, Poléjaeff); Port Jackson (von Lendenfeld).

52. *Leucandra hæckeliana*, Poléjaeff, sp.

Leucetta hæckeliana, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 69.

Vosmaeria hæckeliana, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p 1114.

Locality.—Off Port Jackson (Poléjaeff).

53. *Lelapia australis*, Carter.

(?) *Lelapia australis*, Gray. Proceedings of the Zoological Society of London, 1867, p. 557.

Lelapia australis, Carter. Annals and Magazine of Natural History, August 1886, pp. 138 and 148.

This sponge appears to be of exceptional interest, and I greatly regret that I have never had an opportunity of examining it.

Locality.—Near Port Phillip Heads (Carter).

54. *Grantessa sacca*, von Lendenfeld.

Grantessa sacca, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1098.

Hypograntia sacca, Carter. Annals and Magazine of Natural History, July 1886, p. 42.

This very beautiful sponge is well represented in the collection. All the specimens which I have seen, six in number, are more or less compressed, in the case of large specimens very much so. The finest specimen is 60 mm. in height by 50 mm. in greatest breadth. Von Lendenfeld represents the radial chambers as being perfectly straight and unbranched, whereas, in the Victorian specimens, they branch repeatedly, the branches running parallel with one another to the dermal surface. This may possibly constitute a specific difference, but I am more inclined to think that the figure referred to is incorrect.

Localities.—Port Jackson (von Lendenfeld); near Port Phillip Heads (Carter, and outside the Heads, coll. J. B. Wilson).

55. *Grantessa hirsuta*, Carter, sp.

Hypograntia hirsuta, Carter. Annals and Magazine of Natural History, July 1886, p. 41.

In anatomical characters this species closely resembles *G. sacca*, but differs markedly in external appearance and in the less regularly arranged tubar skeleton, which, though composed of slender spicules, is very dense and confused. The subdermal sagittal triradiates, with inwardly directed basal ray, are not mentioned by Mr. Carter; they are clearly present in my specimens though less obvious than in *G. sacca* on account of the somewhat confused character of the tubar skeleton. The oxea of the dermal tufts are straight, or only very slightly curved. The manuscript illustration which Mr. Carter has kindly sent me shows only a very slight curvature, though he describes them as "curved." The species is abundant in the collection.

Localities.—Near Port Phillip Heads (Carter; and Station 1 and outside the Heads, coll. J. B. Wilson); King Island (coll. Prof. Spencer); Hobart, Tasmania (coll. A. Dendy).

56. *Grantessa hispida*, n. sp.

Small, cylindrical or slightly compressed, solitary persons, with more or less distinct fringe around the terminal oscu-

lum and strongly hispid surface. The largest specimen in the collection is about 40 mm. high by 4 mm. in greatest diameter, the wall of the sponge being only about 0·56 mm. thick. The canal system closely resembles that of *G. sacca*, but the chambers are shorter and less branched. The skeleton is arranged as in *G. sacca*, but the dermal tufts of oxea are less definite and less regularly arranged, and the tubar skeleton is composed of much fewer joints. The spiculation is as follows:—(1) Gastral quadriradiates; very rare, with short apical ray. (2) Gastral triradiates; strongly sagittal, with very long and slender rays; gradually sharp-pointed; basal ray straight, about 0·3 by 0·0083 mm.; oral rays straight or slightly crooked, often unequal in length, about 0·2 by 0·008 mm. (3) Subgastral sagittal triradiates; oral rays widely extended, slightly recurved, sharply-pointed, about 0·12 by 0·0082 mm.; basal ray long, straight, sharp-pointed, varying in length up to about 0·3 mm., and about as thick as the orals, extended in a centrifugal direction through the chamber layer. (4) Tubar triradiates, resembling the foregoing, with similar very long basal rays. (5) Subdermal sagittal triradiates; with very widely extended oral rays lying in the dermal cortex, and long straight basal ray extending inwards through the chamber layer; oral rays up to about 0·2 by 0·01 mm.; basal ray up to about 0·32 by 0·01 mm.; all sharply-pointed. (6) Dermal triradiates; sagittal, resembling the foregoing, but often very irregular and with shorter basal ray. (7) Dermal oxea; long, straight or slightly curved, spindle-shaped, gradually sharp-pointed at each end, length variable, up to about 0·7 by 0·016 mm. in the largest specimen, but much longer and slenderer in one of the smaller ones. The spicules of the oscular fringe do not differ markedly from these.

Locality.—Near Port Phillip Heads (Station 9, coll. J. B. Wilson).

57. *Grantessa poculum*, Poléjaeff, sp.

Amphoriscus poculum, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 46.

Heteropia patulosculifera, Carter. Annals and Magazine of Natural History, July 1886, p. 49.

A careful examination of portions of Carter's and Poléjaeff's type specimens from the British Museum has convinced me that the two are specifically identical, and

I therefore revert to the earlier specific name. I have also two other specimens collected by Mr. Wilson, one of which exhibits very beautifully the "agglomerated" character mentioned by Carter, while the other is only a fragment. The quadriradiates mentioned by Carter are scarce and inconspicuous, and I have not noticed them in the other specimens.

Localities.—Off Port Jackson (Poléjaeff); near Port Phillip Heads (Carter and coll. J. B. Wilson).

58. *Grantessa erinaceus*, Carter, sp.

Leuconia erinaceus, Carter. Annals and Magazine of Natural History, August 1886, p. 130.

This species is readily recognised by its external appearance and the peculiar arrangement of the dermal oxea. The flagellated chambers are elongated and radial, but very irregular and branching, and they communicate with the gastral cavity by unusually long exhalant canals, which unite together in groups. The tubar skeleton is very irregular, but still presents clear traces of the typical "articulate" arrangement. Subgastral sagittal triradiates are present, and the subdermal sagittal triradiates, with inwardly directed basal rays, are very conspicuous. There is a dense dermal cortex of much smaller triradiates, and a less well-developed gastral cortex. Endogastric septa, without spicules, are present in both my specimens, and, as Mr. Carter also mentions them in his, they would seem to be characteristic of the species.

Locality.—Near Port Phillip Heads (Carter, and Station 7, coll. J. B. Wilson).

59. *Grantessa intusarticulata*, Carter, sp.

Hypograntia intusarticulata, Carter. Annals and Magazine of Natural History, July 1886, p. 45.

Hypograntia medioarticulata, Carter, *loc. cit.* p. 46.

I have eleven specimens which I believe to be all referable to this species, and I am strongly of opinion that Mr. Carter's *Hypograntia medioarticulata* is specifically identical with his *intusarticulata.* The minute details of spiculation vary considerable in different specimens, the most characteristic features being the dermal crust of minute oxea or "mortar spicules," and the subdermal sagittal triradiates. The

radial chambers are much branched, which I believe is what Mr. Carter means when he says that they intercommunicate by large holes. The branches run parallel with one another to the dermal cortex; the exhalant canals are short.

Localities.—Near Port Phillip Heads (Carter, and Stations 3, 5, 8, 9 and outside the Heads, coll. J. B. Wilson); Watson's Bay, Port Jackson (coll. T. Whitelegge).

60. *Grantessa* (?) *polyperistomia*, Carter, sp.

Heteropia polyperistomia, Carter. Annals and Magazine of Natural History, July 1886, p. 47.

Locality.—Near Port Phillip Heads (Carter).

61. *Grantessa* (?) *compressa*, Carter, sp.

Heteropia compressa, Carter. Annals and Magazine of Natural History, July 1886, p. 51.

Locality.—Near Port Phillip Heads (Carter).

62. *Grantessa* (?) *pluriosculifera*, Carter, sp.

Heteropia pluriosculifera, Carter. Annals and Magazine of Natural History, July 1886, p. 52.

Locality.—Near Port Phillip Heads (Carter).

63. *Grantessa* (?) *erecta*, Carter, sp.

Heteropia erecta, Carter. Annals and Magazine of Natural History, July 1886, p. 53.

Locality.—Near Port Phillip Heads (Carter).

64. *Grantessa* (?) *spissa*, Carter, sp.

Heteropia spissa, Carter. Annals and Magazine of Natural History, July 1886, p. 54.

Locality.—Near Port Phillip Heads (Carter.)

The last five species are described by Mr. Carter apparently from single specimens, all collected by Mr. Wilson. It appears to me very doubtful whether they are all specifically distinct, and also whether some of them at any rate are not mere varieties of *G. poculum* or *Vosmaeropsis macera*, which they resemble in spiculation. Unfortunately, I have not seen any of the types.

65. *Vosmaeropsis macera*, Carter, sp.

Heteropia macera, Carter. Annals and Magazine of Natural History, July 1886, p. 50.

This species is well represented in the collection. I have been able to convince myself of the correctness of the identification by a minute comparison of a piece of Mr. Carter's type from the British Museum. It is remarkable for its densely agglomerated or colonial habit. Specimens may attain a large size, consisting of very numerous individuals almost completely fused together, usually in linear series, which are inter-connected by cross-bars. The oscula are raised on conical prominences, and each indicates a separate gastral cavity. The canal system is remarkable. The chambers are thimble-shaped and mostly widely separated from the gastral cavity, with which they communicate by a strongly developed system of exhalant canals, each being separated from its exhalant canal by a well developed diaphragm. Those chambers which lie next to the dermal surface still exhibit a radial arrangement with regard to the long axis of the individual. Both subdermal and subgastral sagittal triradiates are strongly developed.

Locality.—Near Port Phillip Heads (Carter, and coll. J. B. Wilson).

66. *Vosmaeropsis depressa*, n. sp.

Specimen flattened, cushion-shaped, with flat under and convex upper surface. About 12 mm. in horizontal diameter, and only 4 mm. thick in the middle. Margin rounded, roughly circular in outline. There is no wide gastral cavity, but several large, branching exhalant canals converge to a single small osculum situate near the middle of the upper surface. Surface smooth ; no distinct oscular fringe.

The inhalant canal-system is quite irregular, commencing in wide lacunar spaces situated beneath the thin, pore-bearing dermal cortex. The flagellated chambers are irregularly but thickly scattered throughout the thickness of the sponge, with no trace of radial arrangement around a central gastral cavity. They are irregularly sac-shaped or thimble-shaped, measuring about 0·2 by 0·09 mm.

The bulk of the skeleton is made up of fairly large, subregular or slightly sagittal triradiates, scattered without definite order throughout the thickness of the sponge, but many with one slightly longer ray pointing towards the

dermal surface. Beneath the dermal surface, but apparent only on the upper surface of the sponge, is a distinct layer of subdermal sagittal triradiates with inwardly-directed basal ray. The dermal skeleton is made up principally of subregular triradiates of various sizes, placed horizontally, but with no definite arrangement; amongst these very minute, slender oxea are scattered, rare on the upper surface of the sponge but abundant on the lower; around the osculum these oxea are numerous and a few are much larger than the rest. Around the main exhalant canals there is a layer of small sagittal triradiates. The forms and dimensions of the different spicules are as follows:—(1) Triradiates of the exhalant canals; sagittal, rays conical, fairly sharply-pointed; basal straight, orals usually slightly incurved or recurved; basal commonly somewhat shorter than orals, which measure about 0·16 by 0·012 mm. Just below the osculum I have seen short apical rays in a few of the sagittal radiates. (2) Triradiates of the main skeleton; subregular or slightly sagittal; rays usually straight, conical, gradually sharp-pointed, rather slender, up to about 0·36 by 0·024 mm. (3) Subdermal sagittal triradiates; similar to the foregoing but a good deal smaller, and with the basal ray much longer than the others. (4) Dermal triradiates; subregular, with long, conical, gradually sharp-pointed rays varying greatly in size, up to about 0·54 by 0·045 mm. (5) Oxea; mostly very minute and slender, sharply-pointed at each end, with one end rather thicker than the other; straight; often slightly roughened; usually short, but varying greatly in length; around the osculum a few much stouter ones occur, but still very small.

Locality.—Near Port Phillip Heads (Sorrento Reef, coll. J. B. Wilson).

67. *Vosmaeropsis wilsoni*, n. sp.

Sponge colonial, consisting of short, thick, sub-cylindrical or truncatedly conical individuals united together by their bases into smaller or larger agglomerations, which may attain a diameter of nearly five inches. Each fully grown individual has a circular osculum at its summit, which may or may not have an oscular fringe, adjacent individuals of the same colony sometimes differing in this respect. The osculum is often provided with a very distinct, membranous diaphragm, situated a short distance within its margin. The

individuals vary in size, and, owing to their peculiar colonial and branching habit, it is difficult to give exact measurements, but we may put down the average adult size as about 20 mm. long and 5 mm. in diameter. A large colony contains dozens of such individuals united together in a complicated and irregular manner. The outer surface is smooth, except for a slight unevenness due to the presence of large triradiates, visible to the naked eye. The colour of spirit specimens varies from pure white to pale brown, but one specimen which I observed as it came out of the dredge was then of a violet purple colour.

The gastral cavity is wide and cylindrical and the wall is about 2·5 mm. thick. There is a dense, thick cortex on both gastral and dermal surfaces.

The inhalant pores are thickly scattered over the surface of the sponge; each leads separately into a short, narrow, cylindrical canal, situate in the outer portion of the dense dermal cortex; these canals soon unite to form larger, but still very well-defined, cylindrical canals, which anastomose with one another by cross-branches and finally lead down to the chamber layer between the dermal and gastral cortex, where the canal system becomes more or less lacunar. The flagellated chambers are thickly scattered through the mesoderm of the chamber layer; they vary much in shape and size, from approximately spherical and only about 0·072 mm. in diameter to elongatedly sac-shaped and as much as 0·37 by 0·13 mm.* The exhalant canals unite together into tolerably large trunks, which penetrate the gastral cortex and open into the gastral cavity.

The skeleton is divisible into four portions, that of the gastral cortex, that of the chamber layer, that of the dermal cortex and that of the osculum. The gastral cortex is about 0·3 mm. thick and its skeleton consists entirely of a dense feltwork of medium-sized triradiate spicules, arranged irregularly but parallel to the gastral surface. These spicules are sagittal, the oral angle being rather wider than the paired angles and the oral rays rather longer than the basal; oral rays straight or very slightly curved towards one another, conical and gradually sharp-pointed, measuring about 0·3 by 0·024 mm.; basal ray straight, conical, gradually sharp-pointed, a little shorter than the orals. The

* These measurements were taken from different specimens, but it would be difficult to make a mistake as to the species in this particular case, and we also find considerable variation in the chambers even in the same section.

skeleton of the chamber layer is made up of large subdermal and subgastral sagittal triradiates, whose basal rays penetrate the chamber layer in opposite directions. These spicules vary greatly in size, the basal rays often extend completely through the chamber layer and are very thick; the oral rays are shorter, more or less curved and widely extended. Frequently many of those which have centrifugal basal rays are not strictly subgastral but have the oral rays situate at various levels in the chamber layer. The rays are conical and gradually sharp-pointed. The dermal cortex is about 0·4 mm. thick and its skeleton is made up almost entirely of triradiate spicules of various shapes and sizes. Towards the inside we find large, regular or subregular triradiates, arranged parallel to the dermal surface, with conical, gradually sharp-pointed rays which measure up to about 1·0 by 0·17 mm.; many, however, being much smaller. On the outside is a much thinner layer of very different, small triradiates. These spicules are irregular in shape and irregularly arranged; their rays are conical and gradually sharp-pointed, but crooked; one of them commonly projects inwards at right angles to the dermal surface; the rays measure about 0·083 by 0·0062 mm. We also find in the outermost part of the dermal cortex a few very minute, straight, slender oxea, whose exact size and shape are very difficult to determine. The oscular skeleton consists of a fringe (not always visible to the naked eye but sometimes strongly developed) of very long and very slender oxea.

I have much pleasure in dedicating this very remarkable and abundant species to Mr. J. Bracebridge Wilson, who has collected all the specimens at present known.

Locality.—Outside Port Phillip Heads (coll. J. B. Wilson).

68. *Heteropegma nodus gordii*, Poléjaeff.

Heteropegma nodus gordii, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 45.

The only specimen which I have seen of this species, unless indeed *H. latitubulata* be considered specifically identical, is a portion of Poléjaeff's type specimen in the British Museum. I have nothing to add to Poléjaeff's excellent description.

Locality.—Torres Straits (Poléjaeff. Poléjaeff also records the species from the Bermudas).

69. *Heteropegma latitubulata*, Carter, sp.

Clathrina latitubulata (provisional, incertæ sedis), Carter. Annals and Magazine of Natural History, June 1886, p. 515.

After describing the external form and spiculation of this remarkable sponge, Mr. Carter remarks that in general form it is very much like Poléjaeff's *Heteropegma nodus gordii*, but totally different anatomically. I have fortunately been able, owing to the kindness of the authorities of the British Museum, to make a minute anatomical examination both of Poléjaeff's type of *Heteropegma nodus gordii*, and also of Carter's type of *Clathrina latitubulata*, and I have also received the latter species direct from Mr. Wilson. I find that in external form, canal-system, and also in the arrangement of the skeleton, the two species are identical, agreeing with the admirable figures given by Poléjaeff in his Challenger Report. The only difference which I have been able to detect concerns the size and shape of the minute quadriradiate spicules of the chamber layer, which are even further reduced in *H. latitubulata* than they are in *H. nodus gordii*.

Locality.—Near Port Phillip Heads (Carter, and Station 1, coll. J. B. Wilson).

70. *Amphoriscus cyathiscus*, Hæckel.

Amphoriscus cyathiscus, Hæckel. Prodromus eines Systems der Kalkschwämme. Jenaische Zeitschrift, Vol. 5, part 2, p. 238.

Sycilla cyathiscus, Hæckel. Die Kalkschwämme, Vol. 2, p. 250.

Locality.—South Australia (Hæckel).

71. *Amphoriscus cylindrus*, Hæckel, sp.

Sycilla cylindrus, Hæckel. Die Kalkschwämme, Vol. 2, p. 254.

Amphoriscus cylindrus, von Lendenfeld. Proc. Linn. Soc. N.S.W., Vol. IX, p. 1103.

Locality.—Port Jackson (von Lendenfeld. Recorded by Hæckel from the Adriatic).

72. *Leucilla uter*, Poléjaeff.

Leucilla uter, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 53.

Polejna uter, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1115.

Localities.—Torres Straits (von Lendenfeld. Recorded by Poléjaeff from the Phillipine Islands and the Bermudas).

73. *Leucilla imperfecta*, Poléjaeff, sp.

Leucetta imperfecta, Poléjaeff. Report on the Calcarea of the Challenger Expedition, p. 67.

Vosmaeria imperfecta, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1113.

Locality.—Off Port Jackson (Poléjaeff).

74. *Leucilla australiensis*, Carter, sp.

Leuconia johnstonii, var *australiensis*, Carter. Annals and Magazine of Natural History, August 1886, p. 133.

This beautiful little species nearly always presents itself under the form of a small, ovoid, sessile, solitary person, with single, circular, naked, terminal osculum. The sponge-wall is comparatively thick, and the dermal surface smooth and hard owing to the large quadriradiates. One very large specimen in the collection, however, is conical in shape, and has a very irregular surface, but this is very exceptional. The species is sometimes social, and rarely consists of two or more individuals united together, or of a single branched individual; but the small egg-like form is highly characteristic. There are numerous specimens in the collection.

The flagellated chambers, thickly scattered through the thickness of the wall, are usually approximately spherical, and about 0·1 mm. in diameter; immediately beneath the dermal cortex, however, they are commonly rather larger and more or less sac-shaped.

Locality.—Near Port Phillip Heads (Carter, and Stations 1, 5, 6, 9, coll. J. B. Wilson, and off Geelong, coll. H. Grayson).

75. *Leucilla prolifera*, Carter, sp.

Teichonella prolifera, Carter. Annals and Magazine of Natural History, July 1878, p. 35, and August 1886, p. 146.

This beautiful species is represented in the collection by a number of fine examples, one of which I have already figured in my paper "On the Anatomy of *Grantia labyrinthica*, Carter, and the so-called Family Teichonidæ" (*Quarterly Journal of Microscopical Science*, Vol. 32, N.S.) The flagellated chambers are approximately spherical and about 0·09 mm. in diameter, thickly scattered through the substance of the sponge. With the exception of the small quadriradiates in the walls of the oscular tubes, and the very

large quadriradiates of the dermal surface, the skeleton is quite irregularly arranged, consisting of scattered triradiate spicules. On account of the large subdermal quadriradiates, though the inwardly-directed apical ray is but short, I propose to include the species in the genus *Leucilla*.

Localities.—Near Port Phillip Heads (Carter, and outside the Heads, coll. J. B. Wilson); Freemantle, W.A. (Carter).

76. *Leucilla saccharata*, Hæckel, sp.

Leucandra saccharata, Hæckel. Die Kalkschwämme, Vol. 2, p. 228.

Leucandra saccharata, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1137.

This remarkable species exhibits a singular irregularity in external form, varying from compressed, irregularly-folded plates to elongated cylindrical tubes, and often attaining a large size. It is common in Port Jackson, whence I have received specimens from Professor Spencer, but I have only seen a single specimen from Port Phillip, collected by Mr. Wilson.

The flagellated chambers are approximately spherical, scattered irregularly, about 0·09 mm. in diameter.*

Localities.—Bass Straits (Hæckel); Port Jackson (von Lendenfeld, and coll. Prof. Spencer); Port Denison (von Lendenfeld); Port Phillip (Station 14, coll. J. B. Wilson).

77. *Leucilla villosa*, von Lendenfeld, sp.

Leucandra villosa, von Lendenfeld. Proceedings of the Linnean Society of New South Wales, Vol. IX, p. 1131.

The only specimen of this sponge which I have seen is a piece of the type from the British Museum, in which subdermal quadriradiates, with long, inwardly-directed apical ray, are abundant. I therefore include the species in the genus *Leucilla*.

Locality.—Port Jackson (von Lendenfeld).

78. *Paraleucilla cucumis*, Hæckel, sp.

Leucandra cucumis, Hæckel. Die Kalkschwämme, Vol. 2, p. 205.

Localities.—Bass Straits and Gulf of St. Vincent (Hæckel. Also recorded by Hækel from Ceylon).

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* Von Lendenfeld gives the diameter as 0·04 mm., but this is probably an error, for he also says that in *Leucandra typica* the chambers "are smaller than in any other case, their diameter rarely exceeding 0·04 mm." (*loc. cit.*, p. 1130.

ART. VII.—*On Two New Tertiary Stylasterids.*

(With Plate XIII.)

By T. S. HALL, M.A.

[Read October 13, 1892.]

No members of the family *Stylasteridæ* have, I believe, been recorded as fossils in Australia, their small size having caused them to be overlooked by collectors. The specimens I have found, were obtained by washing the clays which are so characteristic of our Eocene deposits.

The arrangement of the pores in the cyclosystems of both species seems to warrant the formation of new genera for their reception; at any rate, they will not fit into any of the genera defined by Moseley.

GENUS, *Deontopora* (gen. nov.)

Dactylopores arranged in an arc of about three-quarters of a circle round a gastropore at the centre, and absent on the inner or attached edge of the cyclosystem. There are no styles visible on a superficial examination in the dactylopores, and the presence of matrix in the gastropores prevented the search for them there without mutilation of what is at present, the only specimen I have.

D. mooraboolensis (sp. nov.)

The cœnosteum is branched, but its general form is as yet unknown. The portion found is about 1 cm. long and 2 mm. in diameter. The surface is composed of dense calcareous tissue, and, as in *Astylus subviridis* (Moseley),* is marked by conspicuous longitudinal rounded ridges,

* "On the Structure of the Stylasteridæ." Phil. Trans., 1878, p. 457.

large quadriradiates of the dermal surface, the skeleton is quite irregularly arranged, consisting of scattered triradiate spicules. On account of the large subdermal quadriradiates, though the inwardly-directed apical ray is but short, I propose to include the species in the genus *Leucilla.*

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The flagellated chambers are approximately spherical, scattered irregularly, about 0·09 mm. in diameter.*

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show that it would be required frequently. Possibly then, we have in this instance a near approach to the conditions found in the gonangia of *Cryptohelia.*

When other specimens of this stylasterid are available for examination, the exact position of the genus in the group will, probably, be determinable. The suppression of some of the dactylozoids of a cyclosystem on one side of a gastrozoid, occurs at times in *Stylaster*, and is constant in *Cryptohelia.* In the latter case, however, the suppression is accompanied by the production of a calcareous lamina overhanging and protecting the cyclosystem; but it must be noted that the abortion occurs on opposite faces of the system in *Cryptohelia* and *Deontopora.* In the former, it occurs on the side of the system towards the proximal end of a branch, while in the latter, it is towards the distal end.

In *Astylus*, which is probably the nearest ally of *Cryptohelia*, the homologue of the external lid of the latter is a small tongue-like projection placed somewhat deeply in the gastropore, and dividing it into an inner and an outer chamber.* Sections would, of course, require to be rubbed down to settle whether or not such a process is found in *Deontopora*, or whether, on the other hand, a style is developed. In the former case its nearest ally would be *Astylus*, and in the latter *Stylaster.* If neither style nor process occur, its affinities would be with *Conopora.*† The external characters point, I think, to an alliance with *Astylus* and *Cryptohelia.*

Locality.—Grey clays, Orphanage Reserve, Fyansford, Geelong. Only one specimen found.

GENUS *Leptobothrus* (gen. nov.)

The pores are grouped in cyclosystems; dactylopores not in radial grooves.

The absence of grooves containing the dactylopores is a feature not apparently occurring in any genera in which cyclosystems are found, though it occurs in *Sporadopora* and *Distichopora.*

L. spenceri (sp. nov.)

The specimen figured consists of a portion of a branch which is circular in section. Length 5 mm., diameter 1 mm.

* Moseley, *op. cit.*, p. 458. † *Id.*, p. 503.

The regularity of its form is disturbed by cyclosystems, which are scattered irregularly over its surface. The surface is marked by minute pores, which are slit-like, oval, or circular. They are larger and more distinct than the corresponding pores of *Deontopora,* and are irregularly scattered.

The cyclosystems appear as cylindrical elevations at right angles to the axis of the branch, and irregular in position. The gastropores have well defined walls of similar texture to the surface of the branch. They are cylindrical in shape, and maintain the same diameter right to the top of the cyclosystem, not as in most other genera, opening into a basin-shaped depression. The dactylopores are about eight or nine in number, and open directly on the surface of the ring which forms the boundary of the gastropore, not being placed in radial grooves. The apertures are about midway between the inner and the outer walls. No styles were seen in either kind of pore.

The ampullæ are not noticeable externally, but a large distinct pore, with a slightly expanded external opening, is present at a small distance below the cyclosystem in nearly every instance. In *Cryptohelia,** the ampullæ are always developed in connection with the cyclosystems, and the invariable presence of a pore in this position in the present specimen, renders it probable that it leads into an ampulla. One or two pores which, though somewhat smaller, have a similar appearance, are placed without relation to any cyclosystem. Named as a compliment to Professor W. Baldwin Spencer.

Localities.—A well-sinking in the Eocene beds at Belmont, near Geelong, and at Schnapper Point.

My thanks are due to Professor Spencer for suggestions, and for the loan of works, without which this paper could not have been prepared.

* Moseley, *op. cit.*, p. 477.

DESCRIPTION OF PLATE.

FIG. 1.—*Deontopora mooraboolensis*, enlarged.

FIG. 2.—Two ampullæ seen somewhat from below.

a.—Broken end of a small branch showing cellular appearance, due to the cut ends of the cœnosarcal tubes.

b. b.—Ampullæ, the one on the left being broken.

c.—Pore of ampulla, with definite ring-like wall.

d. d.—Slit-like pores in grooves on surface of cœnosteum.

e.—Pore of ampulla, its wall being broken.

The part shown in this Figure is seen from above in the lower left-hand corner of Fig. 1.

FIG. 3.—Diagram of cyclosystem of *Deontopora*.

Gp.—Gastropore.

Dp.—Dactylopore in groove.

Ps. Ps.—Pseudosepta.

FIG. 4.—*Leptobothrus spenceri*, enlarged.

FIG. 5.—Diagram of cyclosystem of the same.

Gp.—Gastropore.

Dp.—Dactylopore.

Fig. 1.

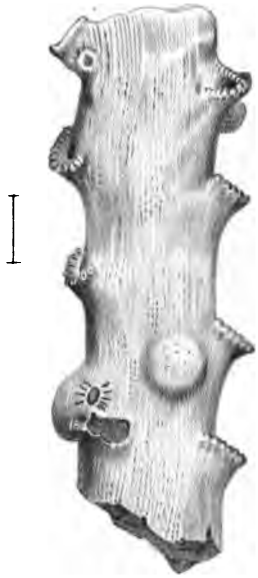


Fig. 2.

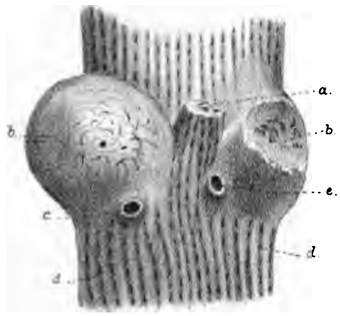


Fig. 3.

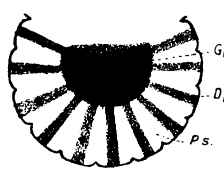
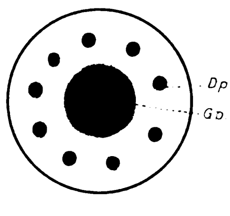


Fig. 4.

Fig. 5.



T. S. H. delt.

R. Wendel lith. C. Troedel & Co. print.

ART. VIII.—*Three rare Species of Eggs hitherto only described from the Oviduct of the Bird.*

By A. J. CAMPBELL, F.L.S.

(Communicated by Professor W. BALDWIN SPENCER, M.A.)

[Read September 8, 1892.]

1. SERICULUS MELINUS, Latham (Regent-bird).

Locality.—Somewhat restricted, being chiefly confined to the sub-tropical coastal scrubs of the Northern portion of New South Wales and Southern Queensland; but its extreme limit appears to be Port Jackson in the South, where the bird has been occasionally observed, and the Fitzroy River in the North. I have recorded having received a skin of a young male from Duaringa, near that River.

Observations.—The Regent-bird, especially the adult male with glorious black and yellow plumage, Gould has well said is one of the finest of Australian Fauna. Last November I undertook an excursion to the Richmond River District, New South Wales, with a view of obtaining, amongst other items, the eggs of the Regent-bird. I found the luxuriant scrubs abounding with Regent-birds, in fact, they were as plentiful there as the Wattle-birds about the Banksia groves of our Southern coast. We experienced no difficulty in procuring our few specimen skins. All that was necessary was to select a balmy day and recline under a Canthium tree, where the birds (males in various stages of plumage and females) came to regale themselves on the bunches of hard yellow berries. Nevertheless, although well aided with a hardy companion, I prosecuted a vigorous and toilsome search through dense labyrinths of hot scrub and thorny brakes of prodigal growth, where the thick foliage of the trees caused a perpetual twilight underneath, but returned without the eggs. It was an experience akin to seeking for the proverbial needle in a haystack. From evidence gained by dissection

and otherwise, it appears that November was too early for the majority of the birds. However, just prior to leaving (19th November) we detected a female carrying a stick, and after much laborious work we succeeded in tracing her through an entanglement of wild raspberries and stinging trees, and were satisfied that she was building in a certain bushy Buoyong (*Tarrietia*) tree, after seeing her return several times, each time with a twig in her bill. Marking the tree, we pointed it out to two young farmers, directing them to send the eggs after us. Some weeks afterwards, I received a doleful letter stating they were unable to climb the tree. However, the next month another farmer, whose scrub paddock I had scoured, following up my instructions, found therein a Regent's nest containing a pair of fresh eggs, which I now have pleasure in describing.

The Eggs.—(*a*) A beautiful, well-shaped specimen, with a fine texture of shell of a light yellowish-stone colour, with a faint greenish tinge, and marked with blotches and spots of sienna, but principally with hair-like markings of the same colour in fanciful shapes and figures, as if a person had painted them on with a fine brush. Intermingled are a few greyish streaks, dull, as if under the shell's surface. All the markings are fairly distributed, but are more abundant around the upper quarter of the egg. The dimensions are 4 cm. long by a breadth of 2·8 cm., somewhat large compared with the size of the parent. The character of the markings resemble much the egg of its close ally, the Spotted Bower-bird (*Chlamydodera maculata*), which I found near Wentworth, River Darling, October 1887, with the difference that the ground colour of the Regent is more yellowish and not of the greenish shade of the Bower-bird. (*b*) Similar to the other specimen, but markings less pronounced and finer in character, with a greater proportion of the dull greyish hair-like streaks, also a little smaller; length 3·95 cm. by a breadth of 2·75 cm.

The Nest.—It was discovered during the last week in December, was placed about 15 feet from the ground, and was observed by the bird sitting thereon. The structure was of such a loose nature—merely a few twigs forming a flat shelf about five inches across—that it fell to pieces on removal from the tree. It was accounted remarkable how the eggs could retain their position in it. The description of the nest verifies the statement found in Gould, that "it is rudely constructed of sticks; no other material being

employed, not even a few roots as a lining," but is at variance with Mr. North's statement, which precedes his description of the egg taken from the oviduct of a bird by Mr. Cockerell, the collector, the only other egg at present known.

Incidentally, the streaky markings of the eggs open up a speculation in reference to coloration. A clever paper read before this Society some time ago, suggested the bowers or play houses of the birds as attributive to the cause. Perhaps Mr. Lucas had in his mind Jacob and the flocks that conceived before the rods and brought forth cattle, "ringstreaked, speckled, and spotted." But all bower-building birds do not lay streaky-coloured eggs, to wit, the Satin Bower-bird (*Ptilonorhynchus*). I succeeded in taking a good photograph of the Regent-bird's bower.

2. SCYTHROPS NOVÆ-HOLLANDIÆ, Latham (Channel-bill)

Locality.—This bird is a wanderer over the whole of Australia, but has not yet been received from the South West portion, and sometimes reaches Tasmania. Is recorded from New Guinea.

Observations.—The Channel-bill is manifestly interesting, because it is the largest of Australian Cuckoos. It is sometimes known inland as the "flood" bird, arriving with such occurrences. Gould described an egg from the oviduct. Mr. North described a similar immature egg from a bird shot on the Macleay River during the first week in November 1884. An egg collected for me (taken from a crow's nest, if I recollect rightly) at Cooper's Creek, was unfortunately broken in transit.

The Egg.—A mature example, in the possession of Mr. D. Le Souëf, Zoological Gardens, Melbourne, may be described as light buff or pinkish-brown in colour, mediumly spotted with pinkish-red and chestnut, with a number of light purplish markings under the shell's surface. In shape and in general coloration, it is not unlike a Strepera's (Crow-shrike) small egg. Texture of shell a little coarse; surface almost lustreless; length 4·2 cm. by a breadth of 2·84 cm. The egg was taken in October 1880, near Inglewood, Queensland, where the Channel-bills were fairly numerous, by Mr. Herman Lau, an observing naturalist, and, as remarkable as it may appear, from the nest of the Sparrow-hawk (*Accipiter*), together with an egg of the bird of prey.

On another occasion, Mr. Lau took a pair of Channel-bill's eggs, together with a pair of the common magpie's *Gymnorhing tibicen*), all fresh from the nest of the latter; while the previous season he took a pair of young Channel-bills from a Strepera's nest, and forwarded them to the Queensland Museum. It would be interesting indeed to learn if the same Channel-bill deposit two eggs in the foster bird's nest, or were they laid by separate birds.

3. LOPHOLAIMUS ANTARTICUS, Shaw (Topknot Pigeon).

Locality.—The coastal scrub generally from Cape York to Gippsland Lakes. Occasional stragglers reach Tasmania. This handsome bird is persistently omitted from the Victorian list, notwithstanding it has been recorded from Eastern Gippsland, and I possess a note of a flock having appeared at Tyrell Creek, near Charlton, November 1889.

Observations.—I enjoyed ample opportunity of observing these pigeons at home in the Richmond River scrub last November, but was much too early for their breeding season. It was delightful as the rising sun was gilding the tops of the taller trees of the scrub to steal along the leafy avenues to some favoured native Tamarind tree (*Diploglottis*), there to watch the Topknot Pigeons, in company with the gorgeously dressed Magnificent and Swainson's Fruit Pigeons, ravishing the agreeable acrid bunches of fruit. The flight of the Topknot Pigeon is rapid and powerful. At times they congregate in large numbers, hence they are sometimes called "flock" pigeons by the dwellers of the scrub. The egg I am permitted to describe is in the collection of Mr. Le Souëf. It was taken from the nest at the end of January 1887, by Mr. Herman Lau, Vandilla, Queensland. Incubation was about a week old, therefore it is probable that this species lays one egg only.

The Egg.—Is dull white, somewhat granulated. In shape, inclined to oval, with peculiarly pointed extremities, especially the smaller end which nips off suddenly. Length 4·5 cm. by a breadth of 3·09 cm.

The Nest.—The bird was shot, not knowing it flew from the nest, which was immediately discovered about forty feet from the ground on a thick branch of a Eucalypt, near the outskirts of the Bunya Mountain scrub. Like those of the majority of pigeons, the nest was of the usual scanty nature of coarse sticks, a few finer inside.

ART. IX.—*Notes on the Mode of Reproduction of Geonemertes australiensis.*

By ARTHUR DENDY, D.Sc., University of Melbourne.

[Read October 13, 1892.]

In the paper on *Geonemertes australiensis** which I had the honour of reading before this Society last year, I shewed, by anatomical examination, that in this worm the sexes are not united in the same individual, but that distinct males and females exist. The males, however, appeared to be much less common than the females and the single one which I obtained was considerably below the average size, though, from the insufficiency of the data, it was impossible to found any generalization upon this fact. At the time when I wrote I had made no observations either as to the mode of copulation of male and female or as to the manner in which the eggs are deposited. Relying upon my anatomical investigations, however, I ventured to indulge in certain speculations on these points, which are contained in the following paragraph :—

"The ova, as already stated, grow to a very large size, measuring up to about 0·6 mm. in diameter. It seems to me almost impossible that they should be discharged through the narrow, preformed genital ducts. I believe that they escape by rupture of the body wall and that the ducts merely serve to convey spermatozoa to them. That these ducts do so convey the spermatozoa I conclude from the fact that I have found spermatozoa in them. Probably the process of fertilization is effected by the male crawling over the female and passing out the sperm as he crawls."†

Since this was printed my friends Messrs. C. C. Brittlebank and H. Giles have collected specimens of *Geonemertes australiensis* and also made some extremely interesting observations upon the method of copulation and egg-laying. I have to thank these gentlemen, not only for an account of their observations, but also for sending me the specimens

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* "On an Australian Land Nemertine (*Geonemertes australiensis*, n. sp.)" Proc. Royal Soc. Victoria, Vol. IV, N.S., p. 85.

† *Loc. cit.*, p. 115.

upon which these observations were based, so that, in the case of the egg-laying habits, I was able to continue the observations on my own account. It will be seen in the sequel that my suggestion as to the manner in which the eggs are discharged from the body was incorrect, while, on the other hand, my views as to the method of copulation receive support. The new observations referred to above are as follows:—

On the 22nd of May last Mr. Brittlebank found, near Myrniong, two specimens of *Geonemertes*, apparently male and female in copulation. The supposed male was very much smaller than the female, and was riding on the back of the latter. The female was about three-quarters of an inch and and the male only about one-quarter of an inch in length when crawling. Mr. Brittlebank observed the specimens for an hour and then posted them to me, but unfortunately they were lost in the post, so that I was unable to determine the sexes by microscopical examination. The notes and sketches made by this careful observer, however, point strongly to the conclusion that the specimens were really male and female. Again, on August 5, Mr. Brittlebank wrote to me that he had found another pair coupled and he adds "the male only crawled over the dorsal surface of the female." Unfortunately these specimens also are not forthcoming for microscopical examination, but Mr. Brittlebank informs me that he watched them for a long time.

The above evidence, though not absolutely conclusive, points strongly to the conclusion that my suggestion as to the manner in which the eggs are fertilized is correct. We have next to deal with the manner in which the eggs are deposited.

On July 4th Mr. H. Giles, of Creekside, Nar-Nar-Goon, found a very fine specimen of *Geonemertes*, which he kept, intending to send it to me alive. He forgot it, however, for some days, and meantime, on July 7th, it deposited a mass of eggs, and on the 13th it was found coiled around a second mass of eggs. On the 15th July I received from Mr. Giles the parent worm and the two masses of eggs which it had laid, the worm apparently in good health, and without any signs of rupture of the body wall, and still containing a number of eggs visible through the integument. I kept this specimen under observation for a long time, and on August 1st found it lying by the side of yet a third mass of eggs which it had evidently just deposited underneath some moss in the

vivarium. The parent animal survived, apparently in perfect health and condition, until September 19th, when I killed and preserved it for future reference.

It will be observed that all these three lots of eggs (which I shall describe presently) were laid by an animal in captivity, and if this were all the evidence forthcoming some critic might perhaps suggest that the laying of the eggs was due to the abnormal conditions of life, as has been suggested in the case of *Peripatus.* Fortunately, however, about the same time two other observers, Mr. Hennel and Mr. Fiddian, found similar masses of eggs in a state of nature, which they kindly brought to me, and which subsequently proved to be undoubtedly eggs of *Geonemertes.* Mr. Hennel obtained his specimen on July 18th, in the damp bark of a gum tree on the Dandenong Creek, and Mr. Fiddian's specimen was found beneath a stone, at Creswick, at the end of July.

The newly deposited eggs of *Geonemertes australiensis* are opaque spherical bodies about 0·6 mm. in diameter and of a white or nearly white colour. Some thirty of these eggs are enclosed together in a sausage-shaped mass of colourless transparent jelly, about half an inch in length, the individual eggs being scattered through the jelly. The surface of the gelatinous matrix is smooth, and the jelly appears to be common to all the eggs, instead of forming a special envelope around each, as in the case of frog-spawn. One such mass of eggs is deposited at a time, and, as is evident from the observations recorded above, at least three can be deposited in succession by the same animal, at intervals of several days, the animal itself remaining perfectly uninjured. Hence it appears almost certain, although the actual deposition of the eggs has not been observed, that they leave the body separately, each by the narrow duct which leads from the sac or capsule containing it to the exterior. This duct, then, appears to serve both for the admission of the spermatozoa and for the extrusion of the fertilized eggs. The source of the gelatinous material in which the eggs are deposited, and also the manner in which the whole mass is moulded into shape, have yet to be discovered. Probably the animal discharges the eggs and pours out the jelly as a secretion from the surface of the body simultaneously. If this were done while the animal was slowly crawling along the result would certainly be one of the curious egg-masses described above. We may compare this hypothetical process with the formation of the slimy

track which under ordinary circumstances the animal leaves behind it when it crawls, only in the latter case the secretion of slime, and consequently the slimy track, are continuous. I do not mean to suggest by this comparison that the gelatinous matrix is identical with the ordinary slime, for that I think highly improbable.

With regard to the development of the eggs my observations have been attended with very little success. The opacity of the embryos, due to the presence of a large quantity of food yolk, renders investigation of them in the living state extremely difficult, and the cutting of sections, which I also attempted, has not so far yielded satisfactory results either. As might have been expected, I have not found any trace of the Pilidium stage so characteristic of some marine nemertines. So far as I can judge at present the development appears to be direct.

On August 26th I examined some of the embryos from the mass of eggs which was found freshly deposited in the vivarium on August 1st. It was easy to distinguish two stages of development. In the first the embryos were spherical and each enclosed in a very delicate transparent membrane. Each was about 0·6 mm. in diameter, opaque and solid-looking, and clothed with short cilia. They revolved slowly inside their delicate envelopes and sometimes slightly changed their shape. In the second stage the embryos had emerged from their delicate envelopes and under the microscope they slowly crawled about, constantly changing their shape in an amœboid fashion, elongating as they crawled. They were clothed with short cilia and were still perfectly opaque. No eye spots were yet visible.

The next stage observed was in the mass of eggs collected by Mr. Fiddian at Creswick, some of which I examined on August 26th, about a month after they had been found. When removed from the soft, investing jelly these embryos elongated themselves greatly and crawled about pretty freely, much after the fashion of the adult worm. A single pair of eye spots was visible at the anterior end. Microscopic examination, by means of sections and otherwise, showed that the proboscis, alimentary canal and nervous system were all well developed, even the characteristic stylets of the proboscis being present. Hence, although these animals had not yet left the investing jelly, the development was nearly complete. The alimentary canal still contained, however, a very large quantity of unabsorbed yolk-granules.

ART. X.—*The Bluff at Barwon Heads.*

(With Plate XIV.)

By G. S. GRIFFITHS, F.G.S.

[Read November 6, 1891.]

This bold headland, at the mouth of the River Barwon, presents some features of geological interest. A crag of grey sandstone, it owes its preservation to the circumstance that its seaward extremity stands upon a basement of hard lava, which rises just above the level of high-water. The result of such an arrangement of the rocks is illustrated by the profiles of two of the cliffs, one of which consists wholly of calcareous sandstone, the lava foundation being wanting.

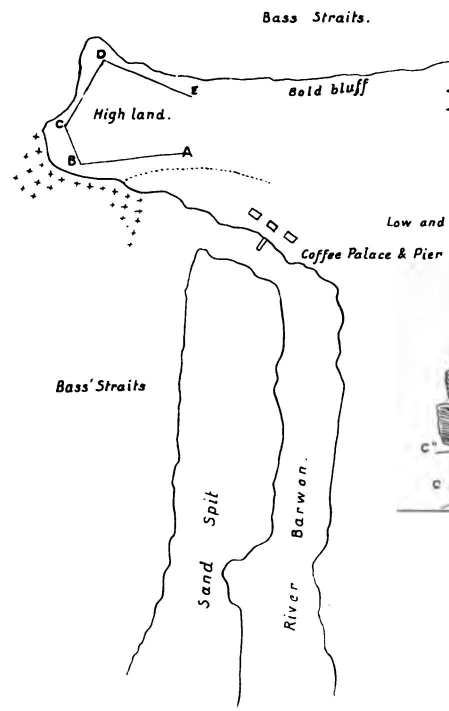
Where the base is of lava, as it is in the cliff at *B* in Section *A B*, the profile has an inclination of about 45°, and can easily be scaled. This shows that the rate of recession of the face of the cliff is much faster than that of the foot. Now, the foot of such cliffs is cut back by both the sea and the weather, while the face is cut back by the weather alone. As the waves and weather together work into the cliff much more quickly than the unaided atmospheric agencies can, we seek for some special condition in the cliff itself, to explain the slanting profile, and we find it in the toughness of the lava base, which here retards the encroachments of the waves.

If we now turn to the cliffs near *D*, we see that one is vertical, and another, which I have not drawn, is deeply undercut at the sea level, so that it continually falls in great slabs, which encumber the beach. Here the entire face of the cliff is of homogeneous material, and the greater wasting power of the sea over the atmosphere shows itself in the profile, which is vertical where it does not overhang its foot. The aerial destruction is not less here, but the sea scour is much greater. Hence the difference between the profiles of the two cliffs.

The next circumstance illustrated by the local features is the effect of a lava flow upon the distribution of shallow water deposits.

The tongue of rock projected in a molten state across a submarine plain of shifting sands, forms a permanent ridge against which the swift currents at once heap up bars of sand. When these become very thick, so that the lower portions are not disturbed for long periods, the base of the mass may become cemented into hard rock by the percolation of lime in solution, or from the moment sand is heaped over the uncooled lava, the gases and acidulated waters may slake the mass into compact strata. This has occurred here, and thus a spit seems to have been formed, over which is spread a bed of clay which may be volcanic ash decomposed *in situ*, or an ordinary littoral deposit. Upon the top of this clay bed is a very horizontal soil bed; just such a sandy loam as is now seen to be capping the cliffs, very fine, and darkened with abundant carbonaceous matter. The next stage is that this land surface—which may have been no more than the muddy fore-shore of the Barwon, or Lake Connewarre—gets covered with sand, which is false bedded, and as far as I can see, unfossiliferous. Whether then this is a sedimentary or an eölian deposit it is hard to say, as false bedding occurs in rocks originating in either way. There are, however, thin beds of water-worn conglomerates intercalated between these false bedded sandstones, which lead me to believe that the coast was sinking and that the sands were spread over this spit by the sea currents. The old land surface humus, although it has been compressed by the overlying sandstone, is still about two feet thick, and its upper margin is very sharply marked off from the deposit above it. This latter rises as a cliff face to a height of from seventy to ninety feet. It is divided into at least three greater divisions, and these again are resolvable into lesser beds, all current bedded. There are differences to be observed which distinguish the larger masses from each other. The middle bed at one part of the cliff especially, contains so much lime that every projection of the rock wall carries its group of stalactites. At a considerable height up the cliff face there is a bed of conglomerate, or breccia, marked *E* in the sections. The stones are small sized; some are basaltic pebbles water-worn, the rest are of sandstone, some rolled and some not, many having a black burnt look. The whole mass is very strongly cemented together by carbonate of lime. It is worthy of

Fig. 1.



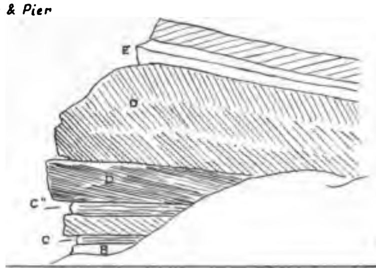
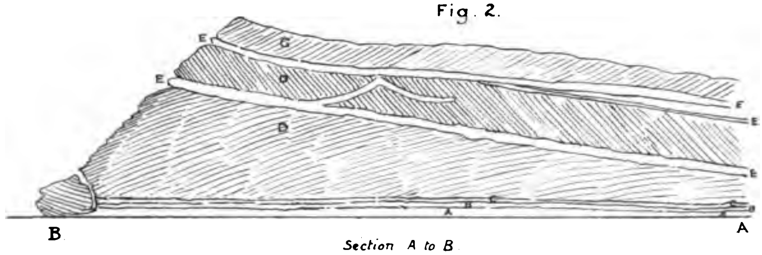


Fig. 3.

Fig. 2.



Section A to B

notice, that while the old land surface at the base is quite level, the conglomerate bed rises from *A* to *B* in that section. Other similar beds lie above this one, none lying horizontally.

The lava flow is not seen to the west of the Barwon Headland (*B*), but some beds of clay, of volcanic origin probably, though destitute of basalt boulders, are to be seen at two levels.

On the beach at *E*, which is about three hundred yards distant west of the last cliff, a bed of rough conglomerate is being broken up by the waves. This is beneath the horizon of the lava flow at *B*, but it nevertheless contains plenty of basalt boulders. Amongst other rocks there are quartz pebbles, and broken shells are plentiful. The stratum is about three feet thick, and it lies between beds of sandstone. Where the scour of the sea has worn down the conglomerate to a smooth flat floor, its varied materials set in a hard matrix give to it the appearance of a gigantic brawn.

The Barwon Head beds must be either late Tertiary or Pleistocene. When they were forming, Bass's Strait extended northwards of the present coastline. Subsequently the area rose again, and when the present cliff tops were probably seventy to ninety feet lower than they are now, one extension of Lake Connewarre southward covered them, and the silt from its floods spread their soil over the barren sand rock. More tilting up of the strata drove back the lake waters to the north; or it may be that the Barwon cut through the sandstone ridge that lay between the lake and the sea, and thus let out and lowered the waters of Connewarre, until they approximated their surface levels to that of the ocean into which they were discharged.

ART. XI.—*On the Conductivity of a Solution of Copper Sulphate.*

(With Plates XV and XVI.)

By W. HUEY STEELE, M.A.

[Read August 11, 1892.]

The following observations were made with the intention of examining, under various conditions, the conductivity of a salt solution, which is of some importance at present, owing to the attention being paid to solutions now by Ostwald, van't Hoff, and others. I chose copper sulphate ($Cu\,SO_4 + 5\,H_2O$) to work with, as that was the most convenient. It is plentiful and easily purified, and copper is a convenient metal to use for making the electrodes.

All the methods of measuring electrolyte resistance by the ordinary Wheatstone bridge and galvanometer are more or less unsatisfactory, the only satisfactory method being that suggested by Kohlrausch, namely, of using rapidly alternating currents and a telephone, instead of steady currents and a galvanometer. The alternate current may be produced by a small dynamo, but much more conveniently by an induction coil maintained by a few cells. A small coil is preferable to a large one, as the statical charge on the electrodes, especially if they be small, is liable to introduce a serious error, besides which is the annoyance of receiving shocks on touching exposed parts of the circuit, if one works with such high E.M.F.'s as are produced in a large coil. The coil I used, when maintained by four freshly charged Grove cells, gave a spark of rather more than a centimetre, but I generally used a much weaker primary current. A slide wire bridge is generally recommended, but I found a resistance box more sensitive and more convenient. The greatest sensitiveness I ever obtained was about 1 in 1500, that being with a resistance of 1500 ohms. The distribution of resistances which is most advantageous in the arms of the ordinary Wheatstone bridge is by no means the best in Kohlrausch's arrangement. In the former, it is

necessary to arrange the arms so that when the resistances are balanced, the maximum current shall pass through the galvanometer, and generally the variable arm can be so arranged that there is no perceptible deflection of the needle. But in Kohlrausch's method, one cannot get complete silence in the telephones, and a variation of say 1 per cent. is more noticeable in a feeble sound than in a loud one, and so (unless the currents be very weak) the arms have to be arranged to send the minimum current through the telephones. This method also differs from the ordinary in its inability to measure with accuracy low resistances, less than 10 ohms, neither can it measure very high resistances more than 50,000 ohms, although, with the box I had, I could otherwise have measured 1,000,000 ohms. Where one tries to measure these high or low resistances, it is found that when the resistances are approximately balanced, it takes a considerable alteration, say 5 per cent. in the variable arm, to produce any perceptible change in the sound in the telephone, and when the change is produced, it is not so much a change in intensity as in quality—it almost seems like an alteration in pitch, though that could not be. Besides overcoming the difficulty introduced by polarisation, there is an enormous advantage in Kohlrausch's method in the way of rapidity. Making an observation is the matter of seconds, instead of minutes.

The cell I used to examine the effect of change of temperature on conductivity was a glass tube (see Fig. 1), about 20 cm. in length, and 1 cm. in diameter, slightly bent. The ends of this fitted into two flat copper cups, with holes in the sides, fitted with slightly conical necks. These cups were about 7 cm. × 5 cm. × 2 cm. The space between the glass and the copper necks was tightly packed with loose hemp, and formed a perfectly water-tight joint. Wires soldered to the cups gave a means of connection, the cups, or rather their interior being the electrodes, the surfaces exposed to the solution being about 80 square cm. The cups were closed at the tops by blocks of indiarubber cut to fit. I had some difficulty, however, in making these quite water-tight, and tried several methods of stopping up the cracks. It was easy enough to stop them at ordinary temperatures, but the difficulty was to find some cement that did not soften at 100° C. Sealing-wax and putty were among the things I tried, but neither remained water-tight at 100° C. A solution of indiarubber in naptha was finally

tried, and with complete success, and I found the whole cell now water-tight even under considerable hydrostatic pressure. Glass tubes were passed through the indiarubber blocks, and Liebig condensers were attached to these by pieces of indiarubber tubing. The inner tubes of the condensers were closed at the top by corks. The condensers were held vertically by clamps, and the cell was thus suspended. It was immersed in oil to a depth of about 6 cm. (dotted line in figure). I had to keep it hung, as my bath was copper. I tested the insulation of the oil, and could get no current through a very slight thickness of it. When heating a solution, air bubbles began to form at about 75° C. The bending of the tube was to allow the escape of these when they became large enough, as well as to allow the steam to escape more readily when the temperature rose to boiling point. The condensers were, of course, intended to keep the solution at a constant strength. Observations of the resistance above 70° were made after the solution had been well boiled, so that there were no air bubbles to increase the resistance of the system.

To observe the temperature, I took a glass tube of the same section and thickness as that of the cell, and corking one end, I partially filled it with the same solution as that with which I was working, and putting the thermometer into this, I put the tube in a slanting position in the bath. Under these conditions, I considered that the temperature of the solution in the second tube ought not to differ much from the temperature of the solution in the cell. For extra security, however, I always kept the temperature within a degree or two for several minutes, and within $\frac{1}{5}$ degree for about half a minute before taking a reading of the resistance. The salt I used was ordinary commercial copper sulphate which I purified by making strong super-saturated solutions in distilled water, and taking the crystals which were deposited before the solution became cold. I obtained the strength of each solution by weighing the amounts of salt and water in it, and checked the results by taking the density with hydrostatic balance, using a glass sinker, and then comparing these values with a series previously obtained and plotted.

I made a very great number of observations altogether, but finally have drawn my conclusions from eight sets, which were the last made, and on which I spent more time and pains than on the others. In the results which follow,

T is the temperature centigrade, R the observed resistance of the system in legal ohms, and k is the conductivity, *i.e.*, the reciprocal of the specific resistance. Taking s as the specific resistance $r = \frac{l\,s}{\pi r^2}$, where r is the mean radius, and l is the length increased by $\cdot 8\,r$ at each end, $\frac{l}{\pi r^2}$ is a constant for the instrument determined by measurement once for all. Thus $k = \frac{l}{\pi r^2} \cdot \frac{1}{R}$ and $\log k = \log \frac{l}{R} - \log R = 1{\cdot}2540 - \log R$, so that the calculation of k from the observed resistances is very simple. The following tables show all the observations used from which I calculated my results :—

5·98 %			25·70 %			9·24 %		
T	*R*	*k*	*T*	*R*	*k*	*T*	*R*	*k*
17	1155	·01554	18	409	·0439	17	852	·0211
31	887	2025	30	320	·0561	30	669	268
41	769	2385	42	260	·0690	42	558	322
50	679	2645	54·6	220	·0816	55	482	372
60	629	2855	70	195	·0920	70	435	413
70	589	305	81	181	·0992	32	639	281
99	587	8343	88	174·5	·1022	70	483	414
97	537·5	334	98	165·0	·1088	95	409	439
94	540	332	96	167·0	·1075	99	404	444
89	548	328	92	170·0	·1056	91	407	441
80	556	323	88	173·0	·1038	88	413	435
70	581	309	81	179·2	·1002	80	420	427
						85	414	434

3·34 %			2·51 %			1·258 %		
T	*R*	*k*	*T*	*R*	*k*	*T*	*R*	*k*
18·9	1800	·00997	18·3	2290	·00784	15·8	4030	·00445
31	1459	·01230	30	1837	·00977	35·2	2800	641
45	1225	1465	40	1598	·01123	52	2350	764
60	1066	1684	50	1440	·01246	65	2120	847
70	999	1796	60	1335	1344	80	1990	902
80	962	1866	70	1266	1118	.....	.....	.....
100	928	1934	80	1218	1474	80	1957	917
99·7	929	1932	97	1174	.1529	90	1915	937
98·5	930	1930	94	1175	1528	94	1925	932
95	932	1926	90	1182	1519	97	1915	937
92	933	1924	85	1192	1506	100	1901	944
90	935	1920	80	1212	1481	97	1903	943
87	940	1909				94	1901	944
85	943	1903						
80	957	1875						

·597 %			·262 %		
T	R	k	T	R	k
99	3270	·00549	99	6270	·00286
97	3250	552	96·5	6260	287
95	3235	555	94	6260	287
93	3230	556	91	6280	286
89	3230	556	86·5	6330	283
87	3235	555	80·5	6430	279
84	3250	552	70·3	6740	266
82	3260	550	18	13850	1296
80	3280	547	30·5	10870	1651
70	3400	528	45	8900	2017
16·3	6650	270	60	7550	2377
30·2	5060	355	70	7000	2564
46	4130	435	80	6550	2740
60	3650	492	70	6900	2601
70	3380	531			

I had now to find, first, the law of variation of conductivity with temperature, and second, its variation with strength of solution. In working out the former, I took 20° C. as my standard, and in what follows, t is the excess of temperature over 20°. I found that each set of observations was given within the limits of errors of observation by the formula $k_t = k_{20} (1 + \alpha t - \beta t^2)$ k_t and k_{20} being the conductivities at 20° + t° C. and 20° C. respectively. To determine α and β as accurately as possible, I worked it out in each case by the "method of least squares," working from the conductivities at 20, 30, 40, 50, 60, 70, 80, 90, and 100° C. found by interpolation from the results given above.

The values I found are shown in the following table :—

n (Solution Concentration).	k_{20}	α	β
25·7 %	·0458	·0254	·000100
9·24	·0224	·0237	140
5·98	·0165	243	144
3·34	·0102	211	125
2·51	·00808	221	136
1·26	·00482	231	138
·597	·00293	215	115
·262	·00135	220	69

From this table it will be seen that α and β are fairly constant for all solutions, though perhaps α increases slightly with the concentration. The errors in β are too great and too irregular to indicate any law of variation. Assuming then that α and β are constant, we find the mean values are, $\alpha = \cdot 0229$; $\beta = \cdot 000121$. In α the probable error of the result is ·00054, or a little less than $2\frac{1}{2}$ per cent. of the whole. Although the values of α and β thus found give the conductivity with fair accuracy, yet they fail in one particular. It will be seen on examining the results in the case of the last two solutions, that there is a temperature of maximum conductivity somewhere between 90 and 100° C. In previous experiments, however, I got maxima between 90 and 100°, with solutions of 3 and 6 per cent., it being very marked in the latter case. It is possible that there may be a maximum in every case, but generally above 100° C., and that its position may vary considerably with very small impurities in the solution, though I do not know what impurity I could have introduced in the one case and not in the other, as in each case I used water distilled in the same way, and salt from the same vessel.

I should remark that, in calculating α and β in the case of the solutions that have a maximum under 100°, I only used the results between 20° and 80°.

It now remained to determine the law connecting conductivity and concentration (k and n). After trying various formulæ and plotting several functions of k and n, I at last suspected that k varied as some power of n, and on taking logarithms and plotting them, I found the resulting curve very nearly a straight line, the deviations from it being such as might arise from errors of observation. Putting $k = a\ n^b$, we have $\log k = \log a + b \log n$. This is a very simple form to work out by "least squares," and I found the constants were $a = \cdot 00403$, $b = \cdot 766$, the average error being 3·4 per cent. The general expression for the conductivity thus becomes $k = \cdot 00403 \times n^{\cdot 766} (1 + \cdot 0229\ t - \cdot 000121\ t^2)$. The curves I, II, and III show the relations between the conductivity and temperature for three different solutions, and may be taken as typical. The curves themselves are plotted from the mean values of the temperature coefficients, and the crosses show the actual observations. As I remarked previously, the coefficients are probably some function of the concentration, but my results are not accurate enough to determine it. Curve IV shows the logarithms of

the different values of the conductivity and concentration; as before, the curve showing the mean calculated values, and the crosses the observed values.

The following table gives the conductivities for several concentrations and temperatures, and may be useful for reference:—

TEMP.	CONCENTRATION.						
	·1 %	·5 %	1 %	5 %	10 %	20 %	30 %
20	·000690	·00237	·00403	·0138	·0235	·0398	·0543
30	·000840	403	490	168	286	484	661
40	·000975	335	569	195	332	562	767
50	·001090	374	635	218	371	628	857
60	·00119	468	693	238	405	685	936
70	·00127	436	741	254	433	733	1000
80	·00133	459	780	267	455	771	1050
90					472	800	1090
100					488	819	1120

DESCRIPTION OF PLATES XV AND XVI.

FIG. 1.—*a*, glass tube; *b b*, copper cups; *c c*, indiarubber blocks; *d*, hemp packing; *e e*, Liebig condensers; *f*, level of solution in cell; *g*, level of bath in which cell is immersed.

FIG. 2.—Curves I, II, III, showing agreement between mean value of temperature coefficients, and values in typical cases. Abscissæ represent temperature centigrade; ordinates, conductivity.

FIG. 3.—Curve IV, showing that the connection between the logarithms of the concentration and conductivity is linear, and consequently, that the conductivity varies as a power of the concentration. Abscissæ, logarithms of conductivity; ordinates, logarithms of concentration.

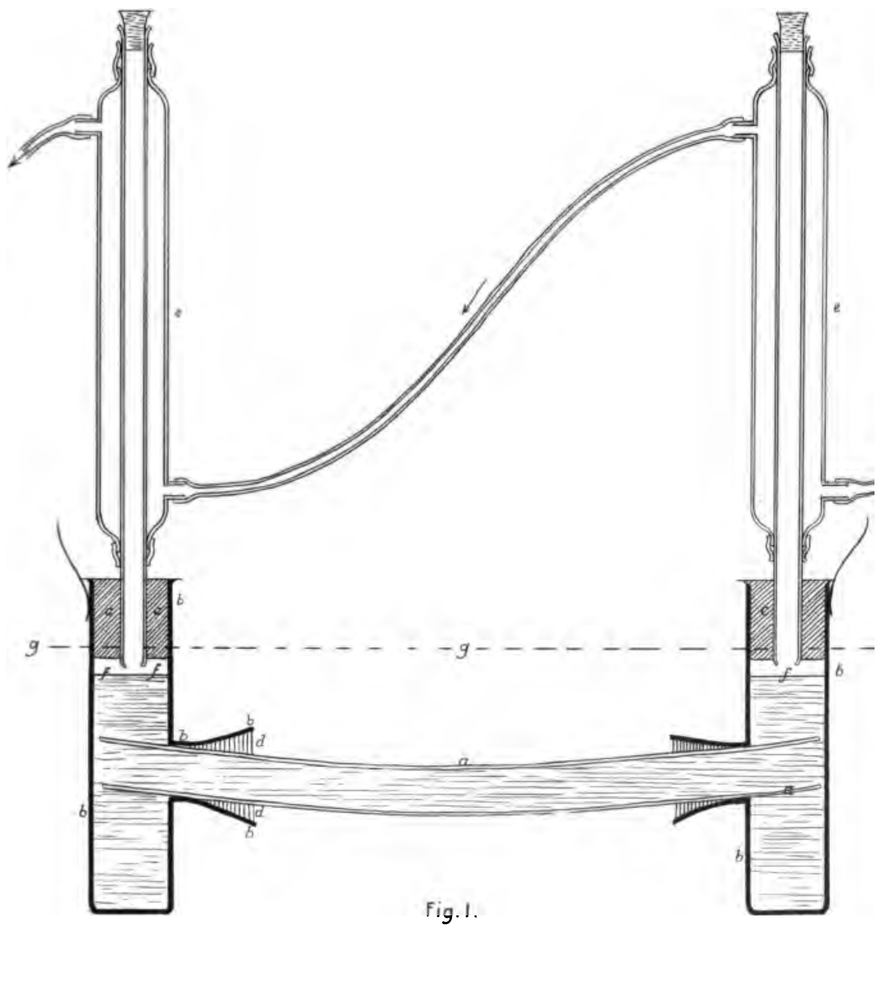


Fig. 1.

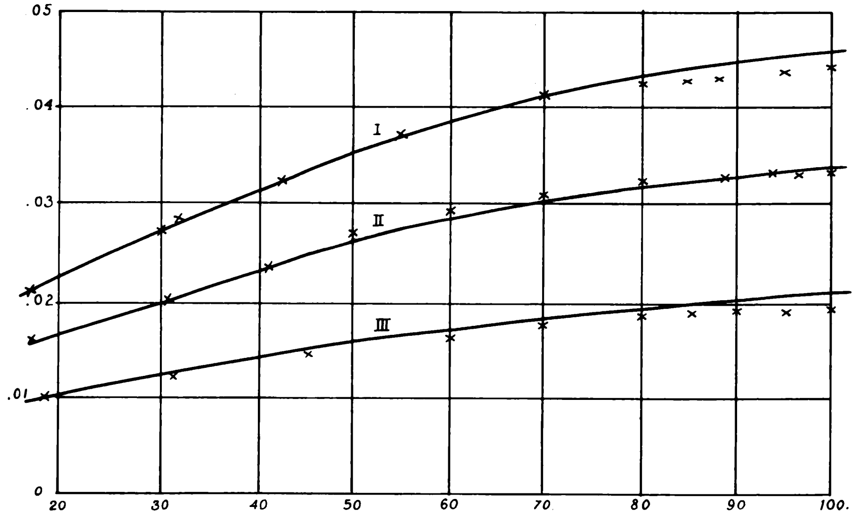

.05
.04
.03
.02
.01
0
20
30
40
50
60
70
80
90
100.
I
II
III

Fig. 2.

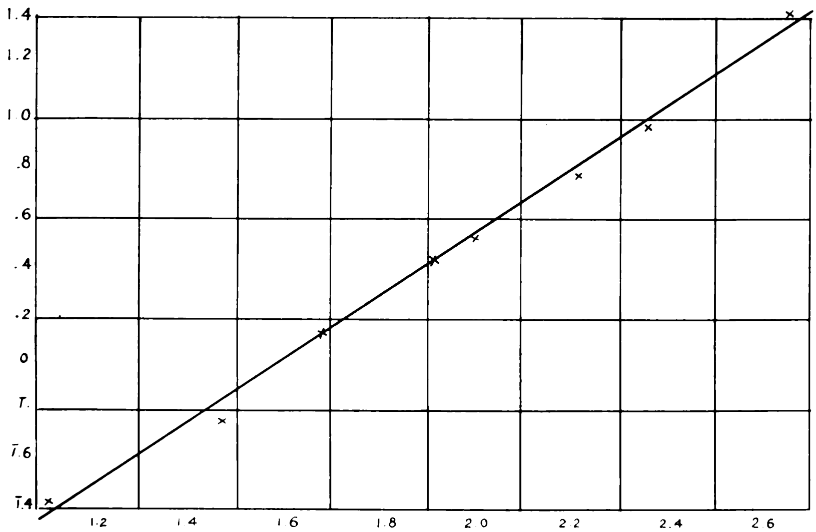

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Fig. 3.

Art. XII.—*The Lichens of Victoria. Part I.*

By Rev. F. R. M. Wilson.

[Read November 10, 1892.]

INTRODUCTION.

1.—The Structure of Lichens.

Lichens are cellular plants, and consist generally of *thallus*, *apothecia*, and *spermagones*.

1. The thallus is usually composed of layers (*a*) *cortical*, (*b*) *gonidial*, (*c*) *medullary*, and (*d*) *hypothalline*.

(*a*) The cortical layer, which occurs on the upper surface of most, and also on the under surface of many lichens, varies in composition, but is generally formed of closely compacted cellules. It varies also in colour, in thickness, in degree of tenacity, and in smoothness of surface. The inferior cortex of many lichens is furnished with *rhizinæ*, or root-like filaments, by which the plants are attached to their substratum.

(*b*) The gonidial system, which generally occurs immediately under the cortex, is specially characteristic of this class of plants. When the gonidial cells are completely filled with bluish or olive-green matter, they are called *granula gonima*; but when the yellowish-green contents are surrounded by a hyaline space within the cell, they are called *gonidia*. Both kinds are usually sphæroidal. In some genera the gonidia are flat and irregular in outline, *chroolepoid*. Some lichens are *chrysogonimic*, with golden yellow gonidia.

(*c*) The medulla, which is found beneath the gonidial system of many lichens, consists of colourless, tubular, and articulate filaments, more or less closely compacted or interlaced.

(*d*) The hypothallus, which is spread under the thallus of some lichens, is usually of a dark colour, and is formed of the filamentous growth arising from the germinated spores, on which the other parts of the thallus are deposited.

2. The apothecium, or reproductive organ, consists of (1) an *excipulum*, either pale or dark, on which lies (2) the *hypothecium*, also either dark or colourless. From the surface of the latter rises (3) the *thecium* or *hymenium*, which contains *thecæ*, generally surrounded by *paraphyses* or club-shaped filaments, all which are usually glued together by the *gelatina hymenia*. The surface formed by the conglutinated apices of the paraphyses is termed the *epithecium* or disk. The hypothecium of nucleated apothecia is styled a *perithecium*.

The various forms of apothecia are (*a*) *lecanorine*, *i.e.*, orbicular and bordered by a thalline margin; (*b*) *lecideine*, *i.e.*, orbicular with no thalline margin, but often bordered by the edge of the excipulum or hypothecium, which is called a *proper* margin, *i.e.*, a margin proper to the apothecium; (*c*) *graphidine*, *i.e.*, like writing, irregular in form, but typically narrow and horizontally lengthened; and (*d*) *pyrenodine*, *i.e.*, globular and nucleated.

The thecæ contain spores, usually 8, but sometimes 1, or 2, or 4, or 6, or sometimes innumerable. The spores vary much in size and form and colour and contents. Some are divided into two or many cells, and some are simple. The outer and inner walls are called the *epispore* and *endospore*.

3. The spermagones are small thalline tubercles, containing a colourless receptacle, within which there arise minute filaments, either simple, when they are termed *sterigmata*, or articulate, when they are termed *arthrosterigmata*. These filaments carry upon their apices very minute bodies, called *spermatia*, which are of various shapes, but generally cylindrical, and which are readily separable and pressed forth in great numbers through a pore in the apex of the spermagone. The spermatia are supposed to fertilise the apothecia, but their function is not known.

There are also other bodies occasionally found on the thallus. *Pycnides* are small organs of a dark colour, containing filaments called *basidia*, which bear, singly at their summits, minute, generally oblong, bodies, called *stylospores*. These are by many authors supposed to be a sort of secondary fructification, and by others affirmed to be minute fungi. *Cyphellæ* are minute excavations in the under surface of certain lichens. Their function is unknown. When they are apparently filled with white or yellow powder, they are called *pseudocyphellæ*. *Cephalodia* are tubercles of various shapes, which are found on many species,

and contain cells or granula gonima. Their functions are unknown. *Soredia* are powdery protrusions of gonidia and of portions of the interior through the surface of the thallus. In some species, the apothecia are often converted into soredia and are sterile. This formerly constituted a genus *Variolaria,* from which this formation is styled *variolarioid.* The surface of the thallus is often roughened by minute thalline excrescences, which formerly gave rise to a genus *Isidium,* by which name this formation is still distinguished. The obsolete genus *Lepraria* was formed of lichens whose thallus is sterile and pulverulent. The obsolete genus *Spiloma* has been found to consist of certain small fungi parasitic on lichens. Various other foreign growths are occasionally detected on their thallus and apothecia. Sometimes minute algæ, or fungi, or portions of mosses will come into view under the microscope; but their structure is evidently very different from that of the lichen with which they are found.

2.—The Uses of Lichens.

Their chief design in nature seems to be to form a vegetable soil for the growth of higher plants. It is remarkable that no poisonous principle has ever been found in any species of lichen; yet, with the exception of a few kinds, they are seldom eaten by animals. Snails devour them, and there are microlepidopterous larvæ which feed upon them. On a coral island in the Indian Ocean, I found lichens with the traces of the claws of crabs, which had evidently sought nourishment from them, especially from their apothecia. The omnivorous *Acarus destructor* seems to infest lichens, both in the field and in the herbarium. Some species afford nourishment to the higher animals. What is called the reindeer moss is a lichen, and is well-known as the chief food of the reindeer in Lapland. There are also species in other lands, which are useful as fodder for domestic animals. Even human beings occasionally use some kinds for food, others are employed for medicine, and others again have proved valuable for the dyeing of cloth.

3.—The Geographical Distribution of Lichens.

The growth of lichens in Victoria depends chiefly on the moisture of the various districts of the colony. On the

plains, and even on the hills, north of the Dividing Range, they are much fewer than on the southern slopes of the Range, and on the hills and in the forests towards the coast. Sub-Alpine species are found on the lofty mountains of the Victorian Alps, and sub-tropical species in east Gippsland. This latter district, indeed, from its position near the warm currents of the Pacific Ocean, and sheltered from the Southern Ocean by Tasmania, is physically, rather a part of New South Wales, than a province of Victoria.

The annual firing of the forests has destroyed, and is destroying, many spots which used to be good collecting grounds. As lichens live only by the influence of air and moisture, their growth is intermittent; and many of them increase very slowly, probably continuing in life for centuries, and their reproductive organs are supposed to remain fertile for ages. The destruction of such plants is a loss which cannot be readily made good. Many of them are of more rapid growth, and some of them are annual.

In favourable localities they are found on the earth, on stones, on rocks, on the bark and leaves of trees, and on other plants, even on other lichens, on dead wood, on decayed moss, on fallen leaves, &c., on dry bones, on leather, on glass. Some prefer one substratum and some another, and some grow indifferently on any. Some saxicole lichens grow only on calcareous rocks, some on siliceous rocks, and some on any. Certain kinds love the mountain, and some grow only on Alpine or sub Alpine heights; others love the plain. Some grow only in wet places, others in the dense sunless shade, either on trees or in caves, or under overhanging rocks. Some like the neighbourhood of the sea, others of rivers or lakes. Some live in the water, either constantly or occasionally submerged, in the channels of streams, or on the seashore; and some flourish on the slate roofs of houses.

4.—The Collecting of Lichens.

The collecting of lichens is best done in fine, but not too dry, weather. Those which grow closely attached to the bark of plants, may be secured by cutting off the bark with a strong sharp knife. If a piece of wood is taken along with the bark, so much the better, as it will prevent the bark curling up when dried. The tough timber of our fences and decorticated hardwood trees, on which some

grow, will need the use of cold chisel and hammer. Rocks, especially granitic and basaltic, require a light well-tempered steel chisel, by which tolerably thin pieces can be detached from almost any rock by the exercise of a little skill.

All that is necessary to preserve the specimens is, to fold them up at once in soft paper (newspaper will do), to prevent them rubbing against one another in the bag in which they are carried home. Those which grow on earth require more careful management. They need to be collected with a sufficient piece of earth, and tenderly wrapped up. When brought home, the earth needs to be pared off under the specimen to a level surface, and then solidified by the application of a solution of isinglass in spirits of wine. The solution, when liquefied in a bottle under a heat of 25° to 30° C., or 77° to 86° Fahr., is dropped with a camel hair pencil on to the earth till saturation, taking care not to let it touch the thallus, which it would discolour. It should be applied underneath. When, after a day or so, the earth, thus saturated, has become dry on the surface by exposure to the air, the specimen should be placed for a few days under sufficient pressure to keep it in shape; it will thus harden into a form suitable for glueing on to paper, as described below.

5.—The Herbarium.

The mounting and arrangement of lichens will be most conveniently carried out by glueing each specimen (with Russian glue) on to the centre of a piece of writing-paper, with a space below to record the name of the plant, the substratum on which it was found, the place and date of finding, and the name of the collector, and with a space above to record notes of examination. These pieces of writing-paper may be then pinned at each end on to quarto single sheets of white cartridge paper with "lill" pins, six specimens of the same species to the sheet, if small, or two if larger. They can thus be easily detached for special examination. The largest specimens may be glued on to the cartridge paper itself. These sheets of specimens should be enclosed in a quarto cover of cartridge paper, one species, or even one variety to each cover, and the covers, put loose, with the open side inwards, into a quarto book cover of pasteboard (three ply), joined together by a strip of strong white binder's cloth, of such width that each cover, when filled, is two inches thick.

For convenience of moving them to fumigate, &c., the books should be arranged in open boxes in an upright row. The most convenient size of box is that of J.D.K.Z. Geneva cases. The boxes being arranged like shelves, the names of the family, series, genus and sub-genus are written in large characters on the backs of the book covers, and thus at a glance down the herbarium, the needed book can be readily seen and easily taken out. The names of the species enclosed in the books should be written on the left hand lower corner of each doubled cover, and thus any specimen can be conveniently found and replaced without delay.

To preserve the specimens from the ravages of insects, they need to be occasionally exposed to the fumes of bi-sulphide of carbon in a covered water-tight case. The quantity of fluid required depends on the completeness with which the case is filled by the boxes. A few ounces in a small cup will serve for a case measuring inside 3 ft. x 2 ft. x 1 ft. 3 in., which will contain three boxes.

6.—The Examination of Lichens.

The examination of lichens for ordinary purposes is most simply and expeditiously carried out by detaching a small portion of thallus or apothecium, or a spermagone, and putting it with a drop or two of water on a glass slide for a short while to soak, then bruizing it down gently with a pen-knife, till it is apparently dissolved. A dry cover is applied, and gently pressed down with a dry knife. The slide is then put under a microscope having a good ¼ inch object glass, and an eye piece magnifying from 250 to 300 diameters. When more careful examination is needed for drawings of structure, a fine section will need to be made of the moistened apothecium, &c., with a section cutter, or with a sharp surgeon's knife, under a watchmaker's lens. It will require great nicety to make a good section, neither too thick and opaque, nor too thin and deprived of large spores. Drawings and measurements may be made with a camera lucida and a micrometer. A home made camera lucida can be easily constructed by cementing a half of a glass cover on to the end of a thin plate of brass, having at the other end an aperture to correspond with that of the eye piece, and bent in the middle at *an angle of* 45 *degrees.*

The chemical re-agents used in examining specimens are decried by some lichenologists as being unreliable. They are, however, valuable assistants in determining species, although they may not be absolutely conclusive taken by themselves. The usual formula by which the solution of iodine (signified by the letter I), is prepared is—iodine, 1 gr., iod. potass., 3 grs., distilled water, ½ oz. For all practical purposes, however, a strong enough solution is made by putting a few grains of iodine into a small phial of water and allowing it to stand a day or so. The solution needs to be kept in a glass-stoppered bottle of dark colour, or covered with tin foil to exclude light. Hypochlorite of lime (signified by the letter C), is prepared by putting a small portion of chloride of lime into a phial of water, and shaking it. When the fluid clarifies, it is ready for use. Hydrate of potash (signified by the letter K), is composed of equal weights of water and caustic potash. It may be well to inform the beginner that when the water is added to the caustic potash, a good deal of heat is evolved. It is well, therefore, to previously warm the bottle, lest the sudden heat should break it. The supply of caustic potash needs to be kept from the air by beeswax round the stopper of the bottle in which it is preserved. The hydrate should also be kept in a stoppered phial, and must be used carefully, as it corrodes clothing, &c. These re-agents may be applied, a drop at a time, by means of thin rods of glass; keeping each rod for its own solution, and wiping them dry on an old rag after using them.

The application of C and K is either to the surface of the plant or to the medulla. The younger part of the thallus is the best for examination. In cold weather, a little heat needs to be applied to hasten the action. This may be done either by placing the phial with the solution in a cup of warm water, or by putting the part under examination close to the mouth and breathing heavily and repeatedly on it after touching it with the solution. First apply C to a portion of the thallus, and note the result. Then to another portion apply K, and, after watching the effect a short while, add C and note the results. To examine the action on the medulla, scrape off a portion of the cortex from another part of the thallus, and apply K and C in the same manner. The more freshly made the solutions are, and the more carefully they are kept from the air, the more reliable are the results.

7.—The Classification of Lichens.

The classification of lichens adopted in the following pages, is that of Nylander, as the most natural, being based upon the consideration of all the parts and organs of the plants, and exhibiting their place in reference to the neighbouring classes of Algæ on the one side, and Fungi on the other.

8.—The History of Victorian Lichenology

Begins with this century. The first lichens collected in Victoria are recorded in an appendix to Flinders' Voyage to Terra Australis, published in 1814. The collection was made in various parts of Australia and Tasmania by Mr. Robert Brown, who accompanied Captain Flinders in his investigation of the coasts of New Holland in 1802. Brown's specimens were afterwards re-examined by Rev. J. M. Crombie, and the result recorded in the Journal Lin. Soc., 1880.

In 1848 and 1849, Dr. Ferdinand Mueller, now Baron von Mueller, collected a number of lichens in Victoria, and sent them to Dr. Hampe, who determined the species. The list appeared in the Report of the Government Botanist to the Victorian Council, 1854. A second parcel of specimens collected in Gippsland and the Australian Alps, was sent to Dr. Hampe, and enumerated by him in Schlechtendals Linnæa, 1856. This list was transcribed into the Government Botanist's Report to the Victorian Legislative Assembly, 1858. These namings by Hampe need revisal, in view of the more minute examination of later lichenology.

A few lichens collected by a visitor from Glasgow, Mr. Hugh Paton, were named by Dr. Stirton, and published by him in the Proceedings of the Royal Society of Victoria, September 1880. They are five in number, and all new to science.

Collections have been made by Messrs. R. Wilhelmi, D. Sullivan, C. Walther, Merrall, C. French, and Mrs. McCann, and forwarded by Baron von Mueller to Europe. The earlier collections were sent to Dr. Krempelhuber, of Blankenberg, on the Hartz Mountains, by whom their names and the descriptions of new species were published in *Den Verhandl. des Kais. Kœn. Zool. Bot. Gesel,* in Wien.,

1880. A list of the names was printed in the Supplement to the eleventh volume of the "Fragmenta Phyt. Austral." Authentic named specimens of most of these are preserved in the Melbourne Botanic Museum. These determinations of Krempelhuber have been revised by Professor Jean Mueller, of Geneva, in the *Ratisbon Flora or Bot. Zeit.* 1887. The later collections received by Baron von Mueller were sent to Professor Mueller, by whom their names and the descriptions of new species are recorded in the *Ratisbon Flora* from time to time. Authentic named specimens of most of them are preserved in the Melbourne Botanic Museum, and a list of those named from 1881 to 1887 is given by Baron von Mueller in the *Victorian Naturalist,* October 1887.

Collections made by Miss F. M. Campbell (now Mrs. Martin), by Mr. F. Reader, and by Rev. F. R. M. Wilson were sent for determination to Dr. C. Knight, of New Zealand. Subsequently, some have been named and described by Rev. F. R. M. Wilson, and lists of them have appeared from time to time in the *Victorian Naturalist,* October 1887, June 1888, August and September 1889, and April 1890; and latterly many, especially of the crustaceous kinds, have been submitted to Professor Mueller, whose determinations have not yet been published.

In 1891, a paper entitled "Lichens Collected in the Colony of Victoria, by Rev. F. R. M. Wilson," was published by the Linnæan Society of London. Many of the names and descriptions there given are reproduced in the present paper, but some are altered. The alterations of names are noted in each case.

Those localities to which no name is appended have been ascertained by the author.

CLASS LICHENES. MICHELI.

Thallus containing gonidia or granula gonima variously disposed, and very often also crystals of oxalate of lime. Fructification consisting of spores in thecæ; gelatina hymenia in most species becoming blue, in others reddish, and seldom unaffected by the application of an aqueous solution of iodine. Spermagonia in minute thalline tubercles distinct from the apothecia.

FAMILY I.—COLLEMACEI.

Thallus usually dark in colour, black, brown or olive, sometimes ashy or bluish, various in form, gelatinous in substance, enclosing granula gonima, which are variously arranged, moniliform or enclosed in sacs or dispersed. Apothecia usually rufescent or pale, seldom black, generally lecanorine or biatorine, rarely endocarpoid.

TRIBE I.—LICHINEI.

Thallus blackish or brown, small, filiform, cæspitoso-fruticulose or depresso-radiate. Saxicole.

GENUS 1.—EPHEBE, Fr. Born.

Thallus fruticulose, filiform, branched and entangled; granula gonima large, arranged chiefly under the cellulose cortex sub-transversely, two or four or more together. Apothecia endocarpoid in thickened portions of the thallus. Spermatia cylindrical.

1. *E. pubescens*, Fr.

Thallus blackish brown, small (about 3 millimetres high, ·1 mm. thick), much branched, somewhat decumbent, slightly rugulose, containing brownish green granula gonima. Diæcious. Spores 8, colourless, oblong, simple or 1 septate, ·011 to ·016 × ·003 to ·004 mm. (Nyl.) Paraphyses indistinct.

Hab. on sub-Alpine rocks, Mount Macedon. Sterile.

Previously named by me (Trans. Lin. Soc. 1890) *Stigonema ephebioides*, Wilson, from a few small imperfectly developed specimens. The lenticular con-colorous bodies then noted by me as apparently connected with the plant, were possibly foreign to it.

GENUS 2.—LICHINA, Ag.

Thallus brownish black, fruticulose, firm; granula gonima bluish; apothecia terminal in sub-globose open thalline receptacles. Spermatia oblong. Spores 8, colourless, ellipsoid, simple.

1. *L. pygmæa*, Lightfoot.

Thallus small (½ inch or a little more), branches flattened towards the apices. Spores ·022 to ·029 × ·011 to ·016 mm. Nyl. Gelatina hymenia unaffected by iodine.

Hab. on maritime rocks washed by the sea. Rep. Gov. Bot. 1854. Doubtful; probably the next species.

2. *L. confinis*, Ach.

Similar to the preceding, but smaller, in more compact tufts, and with terete branches. Spores ·0195 × ·011 mm. (Nyl.)

Hab. on maritime rocks between high and low water, Sandringham, Barwon Heads, Lorne, Warrnambool.

TRIBE 2.—COLLEMEI.

Thallus various in form, membranaceous, lobate or laciniate or microphylline, sometimes fruticulose, sometimes granulose; rigid when dry, turgid and gelatinous when moist. Apothecia lecanorine, in a few cases biatorine, in still fewer endocarpoid.

GENUS 1.—SYNALISSA, D.R. Nyl.

Thallus small, of various forms, incrusting, submembranaceous, granulose or fruticulose. Granula gonima in globular cells. Apothecia innate, lecanorine, or rarely endocarpoid. Spermatia oblong.

1. *S. cancellata*, Wilson.

Thallus black or obscurely olivaceous, submembranaceous, cancellate, minutely atro-granulose, effuse at circumference and encrusting the substratum. Granula gonima light green, contained in gelatinous sacs (inky with I), 1–5 in each; also moniliform among fine elementary filaments. Apothecia minute (to ·25 mm.), prominent in the thalline granules, one in each, at first endocarpoid, at length rufescent, lecanorine, elevated, disk concave or plane, with thalline margin withdrawn. Spores colourless, ellipsoid or ovoid, simple, with narrow epispore, ·01 to ·012 × ·004 to ·006 mm. Paraphyses slender; thecæ cylindrical; gelatina hymenia I, vinous, then yellow.

Hab. on sub-Alpine rocks and moss, Mt. Macedon.

Previously named by me (Trans. Lin. Soc. 1890) *S. micrococca*, Born. et Nyl.

GENUS 2.—COLLEMA, Ach. Nyl.

Thallus very various, granula gonima moniliform, no distinct cortical layer. Apothecia rufescent, usually lecanorine; hypothecium distinctly cellulose; spores eight, colourless, commonly multilocular, rarely simple.

SUB-GENUS 1.—COLLEMA, *Spores ellipsoid.*

1. *C. læve*, Taylor.

Thallus olivaceous, under surface paler or cinerascent, smooth, rotundo lobate, undulate. Apothecia rufous or fusco-rufous, plane, at length convex, with a thin entire thalline margin. Spores fusiformi ellipsoid, ·013 × ·004 mm., 3 to 5 septate, and also longitudinally divided. Granula gonima moniliform. Gel. hym. blue with iodine.

Hab. among mosses on granitic rocks, M'Crae's Island. Rep. Gov. Bot. 1854. Traawool, Beaconsfield.

Previously named by me (Trans. Lin. Soc. 1890) *Leptogium olivaceum*, Wilson.

Form *granulatum*, Wilson.—Thallus olivaceous or fusco-olivaceous, here and there plumbeous; beneath paler, firm, moderate (one inch wide), smooth, very often near centre or wholly obscurely granulate.

Hab. on bark of trees, Warrnambool, Gippsland, Kew.

Form *fimbriatum*, Wilson.—Thallus crisped at circumference, and isidioso fringed. Sterile.

Hab. on bark of trees, Warrnambool.

Form *isidiosum*, Wilson.—Thallus plumbeo cœrulescent, here and there olivaceous, membranaceous, thin, plicato undulate, more or less covered with cœsious or obscurely plumbeous isidia.

Hab. on bark of trees, Warrnambool, Gippsland.

2. *C. plumbeum*, Wilson.

Thallus plumbeous, small, complicate, membranaceous, rotundo-lobate, lobes undulate. Apothecia minute, often crowded, rufous brown, sessile, plane, thalline margin entire.

Spores ellipsoideo-fusiform, ·02 × ·004 mm., 5 septate, and also longitudinally divided. Gran. gon. oblongo globose, ·003 to ·005 mm., moniliform ; yellow with iodine. Gel. hym. blue with iodine.

Hab. on mosses on trees, Warburton.

3. *C. furvum*, Ach.

Thallus dark fuscous green or nigro-olivaceous, membranaceous, granulate, lobate, lobes complicate, often undulate; blood-red with iodine. Apothecia fuscous, plane, thalline margin entire. Spores ovoid or ellipsoid, ·018 to ·024 × ·009 to ·011 mm., 3 septate, irregularly murali-locular.—B. v. M., *Vic. Nat.*, Oct. 1887, p. 88.

4. *C. atrum*, Wilson.

Thallus black, moderate (to 1½ inch), circumference lobate, complicato squamose, thick, cartilaginous, granulato-corrugate. Apothecia black or dark rufous or sometimes pale, with entire thalline margin, attaining 1 mm. diam. Spores ovate or fusiformi ellipsoid, acuminate at one or both apices, ·018 to ·026 × ·005 to ·006 mm., 3 to 4 loculate. Thecæ clavate, intensely blue with iodine. Paraphyses slender, crowded.

Hab. on calcareous maritime rocks, Warrnambool.

SUB-GENUS 2.—SYNECHOBLASTUS, *spores elongate.*

1. *S. congestus*, Wilson.

Thallus black or atro-fuscous, small (to 1 inch) cartilaginous, difformi-lobate, lobes rotundate, undulate, circumference elevated, incrassate, arcuate. Apothecia black or pallid or dark red, moderate (2 mm. diam.), plane, with thickened margin, at length convex, immarginate. Spores cylindrical or ellipsoideo cylindrical, sometimes curved, often acuminate at the apices, simple or 1 septate, containing two to five locules, ·017 × ·0035 mm. Paraphyses thick, inarticulate. Gel. hym. blue with iodine, thecæ intensely blue. Gran. gon. conglomerated into sacs, two or three or more in each, not moniliform.

Hab. on mosses, &c., on calcareous maritime rocks, Warrnambool.

2. *S. quadrilocularis*, Wilson.

Thallus fusco olivaceous or nigricant, membranaceous, adhering, lobate, thicker at circumference, crisped. Apothecia moderate, crowded, black or rufous black, plane or somewhat concave, thalline margin entire. Spores cylindrical, rounded at each apex, somewhat curved, ·02 to ·03 × ·003 to ·005 mm., 3 septate. Paraphyses slender, inarticulate. Gran. gon. moniliform, or sometimes conglomerated in fours into gelatinous sacs.

Hab. on mosses on sub-Alpine granitic rocks, Mt. Macedon.

3. *S. senecionis*, Wilson.

Thallus green or fuscous green or olivaceous, under surface cæruleau green, thin, membranaceous, smooth, shining or somewhat shining, or sometimes granulato rugulose, moderate (2 to 3 inches), rotundo lobate, lobes imbricate, undulato crispate, circumference ascending. Apothecia rufous or testaceo rufous, about 1 mm. diam., often crowded, plane or rather convex, thalline margin entire. Spores elongato fusiform, straight or curved or spirally contorted, ·03 to ·05 × ·004 to ·008 mm., 3 to 9 septate. Gel. hym. blue with iodine. Gran. gon. oblong or reniform (1 to 2 mm. long), or subglobose (1 mm. diam.)

Hab. on bark of Senecio bedfordii, rarely and smaller on bark of Prostanthera lasianthus, Mt. Macedon; Lakes Entrance, Gippsland. When young, the thallus is tense and vivid in colour, like a thin, glistening film of green paint.

4. *S. leucocarpus*, Taylor.

Thallus 1 to 3 inches diam., foliaceo membranaceous, smooth, olivaceous, lobes rotundate, undulate and plicate, margin flexuose. Apothecia often crowded, albocarneous; disk convex, pruinose; margin entire, at length concealed. Spores elongato fusiform, often acuminate at apices, 3 to 5 septate, ·03 to ·05 × ·008 to ·01 mm.

Hab. on trees, Cromb., Journ. Lin. Soc., XVII; Wilson's Promontory, Gov. Bot. Rep., 1854; Krplhbr., *Verhandl. Zool. Bot. Gesells.*, in Wien, 1880; by Curdie's Creek, Mt. Macedon, Warburton, Lorne, Glenmaggie, Beaconsfield, Mt. William, Dandenong Hills.

Var. 1 *petræus*, Wilson.—Obscurely olivaceous or nigricant; lobes smaller, somewhat complicate. Apothecia small,

nigricant, seldom carneous, albo pruinose, disk plane. Spores pluri- (about 7) septate, ·03 to ·04 × ·004 to ·005 mm.

Hab. on granitic rocks in mountain streams in Tallarook Ranges.

Var. 2 *minor*, Wilson.—Much less and darker than the type; submonophyllous, rotundate, often obscurely furfuraceo granulose. Apothecia minute and much crowded. Spores as in type.

Hab. on trees near Lake Wat Wat, Gippsland.

5. *S. glaucophthalmus*, Nyl.

Thallus olivaceo-fuscous, ½ inch or more diam., here and there fenestrato dissected, scrobiculate and often granuliferous. Apothecia glaucous lilac, plane or somewhat concave, thalline receptacle prominent, margin very thin. Spores as in *S. nigrescens*, to which this species is allied.

Hab. on bark of trees and bushes; *Leptogium glaucophthalmum*, B. v. M., *Vic. Nat.*, Oct. 1887, p. 89; Warrnambool, Mordialloc, Cunninghame, Buninyong, Lake Wat Wat.

6. *S. nigrescens*, Huds.

Thallus black green, thinly membranaceous, submonophyllous, orbicular, depressed, rotundato lobate, radiately rugoso plicate. Apothecia obscurely rufous, plane, crowded, thalline margin entire. Spores fusiformi cylindrical, often pluriseptate, ·034 to ·042 × ·005 mm.

Hab. on trunks of trees, Warrnambool, Mordialloc, Cunninghame, Buninyong, Metung.

GENUS 3.—LEPTOGIUM, Fries.

1. *L. biloculare*, Wilson.

Thallus plumbeous, membranaceous, small (½ inch) laciniato lobate, lobes sinuate and undulate. Apothecia pale rufous, minute (2–7 mm. diam.); thalline margin prominent. Spores fusiformi ellipsoid, bilocular, ·015 × ·006 mm. Gel. hym. blue with iodine.

Hab. on the bark of a tree, Mt. Macedon.

2. *L. sinuatum*, Huds.

Thallus plumbeo-fuscescent, rotundato lobate, reticulato rugulose, lobes crowded, imbricated, margin entire or crenate,

sub-erect. Apothecia brown, scattered, small, sessile, concave, margin smooth, entire, elevated. Spores oblongo ellipsoid, attenuated at apices, irregularly murali locular, ·02 × ·008 mm.

Hab. on mossy rocks, Mt. Macedon, Kilmore, Lorne.

3. *L. lacerum*, Ach. var. *intermedium*, Arn.

Thallus plumbeous, or pallido plumbeous, or fuscescenti plumbeous, very thin, smooth or slightly rugulose, undulate and plicate, laciniato lobate, lobes rotundate or lacerate; margin crisped, irregularly crenate or spatulato fimbriate, fimbria often repeatedly branched. Apothecia pallido rufous, not frequent, small or moderate, margin elevated. Spores oblongo ovoid, narrow at one or both apices, murali locular in typically 3 series, ·025 × ·008 mm.

Hab. on mossy rocks and bushes in bed of stream, Cobden, Mt. Macedon, Beaconsfield, Lorne.

Aspect intermediate, between *lacerum* and *tremelloides*.

Var. 2. *pulvinatum*, Hffm.—Thallus dark brown, smaller, pulvinate, lobes minute, much crowded, denticulato laciniate; sterile.

Hab. on earth, Kew; rare.

4. *L. tremelloides*, L. var. *azureum*, Sw. = *Collema azureum*. Report Gov. Bot. 1854.

Thallus plumbeo glaucescent, here and there fuscescent, smooth, lobate, imbricate and crispate. Apothecia rufous, elevated, margin entire, plumbeous or pallid. Spores ellipsoid, acuminate at apices, 5 septate and also longitudinally divided, ·016 × ·006 mm.

Hab. on trees (*Collema azureum*), McCrae's Island, Rep. Gov. Bot. 1854; Cobden, Lake Elingamite, Black Spur, Mt. Macedon, Warburton, Lorne, Beaconsfield, Lakes Entrance.

Var. 2. *muscitegens*, Wilson.—Darker and firmer than the type, less undulate, ascending.

Hab. on stems of mosses on trees, Warburton, Korumburra.

Var. 3. *isidiosum*, Wilson.—Much smaller than the type, partially covered with a granulose isidium. Apothecia small, occasionally isidiose on margin.

Hab. on mossy bush, Cunninghame.

5. *L. philorheuma*, Wilson.

Thallus more or less obscurely plumbeo cinereous or brown, very thin, to ½ inch wide, sub-ascending, lobate, plicato undulate; margin crenate, sinuate and crisped. Apothecia small (1 to 1·5 mm.), disk more or less obscurely rufous, sometimes black, concave or plane; thalline margin entire, thick, rounded, elevated, at length thin, equal. Spores ovate, 3 septate, and also longitudinally divided, ·015 × ·007 mm.

Hab. on mosses and rocks in the channels of streams, Curdie's Creek, Lorne, Tallarook.

Named by Dr. Knight as *L. dactylinum*, and so reported by me (Trans. Lin. Soc. 1890).

6. *L. victorianum*, Wilson.

Thallus obscurely plumbeous, here and there rufo-fuscous, under surface nearly concolorous or sub-cinerascent, large (3 inches or more diam.), more or less confusedly rugulose, rotundo lobate, lobes undulate, firm, but in old lobes thick and occasionally fusco-furfuraceous, as if deprived of cortex, sometimes clothed with squamules. Apothecia moderate, sometimes rather large rufous or fusco-rufous, thalline margin sometimes excluded, more generally plicate or granulate or briefly laciniate. Spores ovoideo fusiform, often acuminate at the apices, typically three septate, often with the central locules longitudinally or obliquely divided, ·013 to ·017 × ·005 to ·006 mm. Granula gonima moniliform.

Hab. among mosses, on trees and rocks abundantly, Mt. Macedon, Black Spur, Cobden, Sandringham (one specimen), Warburton, Korumburra.

Allied to *L. chloromelum*, Sw., and perhaps a variety of it.

7. *L. phyllocarpum*, Pers. var. *dædaleum*, Flot.

Thallus fusco plumbeous, here and there pallido plumbeous, firm, lobate, large (three or four in. diameter), longitudinally and very closely undulato rugose, or finely and acutely corrugate, under surface paler. Apothecia dark rufous, often large, thalline margin thick, densely corrugato rugulose, spores ellipsoid, attenuate at each apex, five septate, and also longitudinally divided, ·03 to ·034 × ·012 to ·015 mm. (Nyl.)

Hab. on trees and bushes, Warrnambool, Lake Victoria, Cunninghame, Lake Wat Wat; abundant, but rather rare in fruit.

8. *L. pecten*, Wilson.

Thallus minute, very thin, squamuliform, plumbeous or brown, margin digitato crenate, often pulvinato crowded. Apothecia large for the size of the plant (1·5 mm. diameter), rufescent, concave, with a thin, pallid margin, often immarginate. Spores ellipsoid, three septate with central locules often longitudinally divided, ·016 to ·024 × ·008 mm.

Hab. on dead or old bark of trees, not common, Mordialloc, Mt. Macedon, Glenmaggie.

9. *L. Burgessii*, Lightfoot.

Thallus plumbeous or brown, laciniato lobate, complicate, lobes variously margined, undulate and curled, under surface cinerascent and albido tomentellose. Apothecia dark rufous, somewhat large, plane or concave, margin thin, entire, or sub-foliaceo-crenulate. Spores ellipsoid, attenuate at each apex, three septate, and also longitudinally divided, ·03 to ·04 × ·012 to ·015 mm.

Hab. on bushes and trees and mossy rocks, Curdie's Creek, Warrnambool, Buninyong, Lake Wat Wat, Mount William; not common.

10. *L. inflexum*, Nyl.

Thallus plumbeous or plumbeo cærulescent, membranaceous, dilated, two to three inches diameter, smooth, laciniato incised, margin inflexo convolute, broadly sinuate and crenulate; under surface pallescent, very thinly tomentellose, but wide at margin. Apothecia rufous, plane or somewhat concave, rather large, appressed, foliaceo crenulate. Spores ellipsoid, attenuate at each apex, plurilocular, ·03 to ·036 × ·013 to ·017 mm. (Nyl.)

Hab. on rock at Waterfall, Upper Maffra.

Var. *limbatum*, Wilson.—Thallus orbicular and rosulate, margin for the most part densely and minutely fimbriate.

Hab. on trees and mossy logs in sub-Alpine localities, Black Spur, Warburton, Mt. Macedon.

11. *L. denticulatum*, *Vic. Nat.*, Oct. 1887, B. v. M.

12. *L. hypotrachynum*, Mull. Arg.

Thallus about 4 centim. wide, laciniæ horizontal or ascending, obovate, obtusely lobate, margin entire, thinly coriaceous, fusco olivaceous, both surfaces concolorous, smooth above or slightly rugulose, crowded beneath with polymorphous prominences, obovoid, obtuse, entire or obtusely lobate, exasperate or verruculose tomentellose. Apothecia 2 mm. diam., spores fusiformi ellipsoid, 5 septate, multilocular, ·025 × ·01 mm. Mull. Lich. Beit. XII, 12, Ratisb. Flora.

13. *L. australe*, Hook and Tayl.

Thallus foliaceo membranaceous, thin, blackish olive, smooth, lobes ascending, sub-imbricate, somewhat concave, rotundate, undulate, entire, under surface paler, sub-tomentose. Apothecia elevated, black, at length convex, margin thin, entire. McCrae's Island, Rep. Gov. Bot. 1854.

14. *L. rugatum*, Hook and Tayl.

Thallus gelatinous membranaceous, 3 inches diam., fuscous green, covered with close longitudinal plaits; lobes crowded, ascending, oblongo rotundate, crenate, somewhat concave, with minute granulate stipitate isidia expanding into thalline lobes, sterile.

Hab. on trees, McCrae's Island, Rep. Gov. Bot. 1854.

FAMILY II.—MYRIANGIACEI.

GENUS 1.—MYRIANGIUM, Mnt. and Berk.

Thallus black, noduloso pulvinate, cellulose, unstratified. Apothecia sublecanorine, sphæroideo cellulose. Spores 8, colourless, irregularly septate.

1. *M. duriœi*, M. and B. = *M. durieui*, of De Bary.

Thallus black, opaque, small, tuberculato glomerate or nodoso confluent, often depresso pulvinate. Apothecia minute, black, slightly impressed. Spores oblong or oblongo ovoid, variously septate, ·017 to ·024 × ·007 to ·008 mm.

Hab. on bark of trees, Mount Macedon, Sandringham, Korumburra, Kilmore.

2. *M. dolichosporum*, Wilson.

Thallus black, opaque or slightly shining, small (2 to 5 mm. wide and 2 mm. high), unequal. Apothecia numerous, nearly covering the thallus and concolorous with it, stipitate; epithecia subrufescent, plane or concave, to 1 mm. broad, with rotundo obtuse thalline margin; stipe sometimes 1 mm. long, tapering downwards. Thecæ sphæroidal, dispersed in the cellular substance of the epithecium. Spores cylindrical, simple or obsoletely septate, arcuate, somewhat acuminate at apices, with minute guttæ arranged in the longitudinal axis, ·04 × ·006 mm. Gran. gonim. ·002 to ·007 mm. diam., often conglomerate. Texture of thallus fuscous, cellular, cells angular, ·003 to ·005 mm. diam. Cells in epithecium spherical.

Hab. on twigs of Hymenanthera banksii, Maffra.

The whole plant is often covered with the scyphophoroid apothecia standing out in all directions, and of various sizes and stages of development. The epithecium is almost identical in texture with the epithallus, but is generally concave and slightly rufescent. In old apothecia it is worn into cavities, which give it a granulato rugulose appearance. Both thallus and apothecia contain granula gonima, usually conglomerate. When a dried specimen is submerged in water, there arise from it on all sides streams of minute air bubbles for a considerable time, showing the porous nature of the plant. It does not, however, appreciably increase in size when moistened as the Collemacei do.

FAMILY III.—LICHENACEI.

Thallus various in colour, white, whitish, cinerascent, flavicant, rufous, fuscous, very rarely nigricant, and various in form, filamentous, foliaceous, squamose, crustaceous, pulverulent or evanescent. The gonidial stratum very generally of true gonidia. Apothecia various in form, stipitate, lecanorine, peltate, patellulate, lirellate or pyrenocarpous.

SERIES I.—EPICONIODEI.

Apothecia with the spores naked, collected into a sporal mass on the surface.

TRIBE 1.—CALICIEI.

Thallus crustaceous, granulose or obsolete, yellow or flavovirescent, or cinerascent, or whitish, or none. Apothecia cupuliform, sessile or stipitate.

GENUS 1.—SPHINCTRINA, Fr. pr. p. D. N.

Thallus none. Apothecia parasitic on *Pertusariæ*, globoso turbinate, shining, black, sessile or shortly stipitate. Spores 8, nigrescent, simple.

1. *S. microcephala*, Nyl.

Apothecia black, globoso turbinate, briefly stipitate, nearly sessile, capitula small (about ·1 mm. broad), spores nigricant, fusiformi ellipsoid, nearly globose, but acuminate at apices, epispore thick, reddish, ·01 to ·012 × ·004 to ·008 mm.

Hab. on some pertussaria, on bark of Hymenanthera banksii, Maffra.

Form *tenella*, Wilson.—Like the type, but with a smaller capitulum and longer stipe (to ·5 mm.)

Hab. along with type, Maffra.

GENUS 2.—CALICIUM, Ach. Nyl.

Thallus granulose, powdery, crustaceous, squamulose, or altogether evanescent. Apothecia generally black, stipitate or subsessile, capitula globose, or turbinate, or cupular. Spores fuscous or nigricant. Spermatia short, oblong.

1. *C. chrysocephalum*, Ach.

Thallus citrine or obsolete. Apothecia small (·6 mm. high), black, stipe slender (·06 mm. thick). Capitulum small (·12 mm. broad), turbinate; beneath citrino suffused. Sporal mass umber brown; spores fuscous, globose, ·003 to ·006 mm. diam.

Hab. on decorticated decaying eucalyptus, near river, at Maffra, Kilmore.

Var. *filare*, Ach.—Stipe longer and more slender (to ·8 × ·4 mm.); capitulum smaller; sporal mass protruding upwards to a great height.

Hab. along with type, Maffra.

2. *C. phæocephalum*, Borr. var. *phædrosporum*, Wilson.

Thallus white, or whitish, with pale glaucescent verrucose congested granules, which are sometimes dissolved into citrine soredia. Apothecia atro-fuscous, with slender stipe (about ·2 mm. high, ·1 mm. thick), the upper part citrino suffused; capitulum hemispherico-turbinate or sub-globose; margin citrino suffused; sporal mass from fulvous to umbrine. Spores dilutely nigrescent, very nearly colourless, delimitated by a dark line; form variable, globose or ellipsoid, simple, nucleated, diameter ·002 to ·004 mm.

Hab. on decaying decorticated eucalyptus, near Kilmore.

I am doubtful whether the granules of the thallus belong to this lichen, or are an undeveloped form of some other. Perhaps the plant is of a new species, which may be called *C. phædrosporum*.

3. *C. niveum*, Wilson.

Thallus snowy white, thick, or cinerascenti albid, thinner, effuse, rimulose with convex areolæ. Apothecia minute (·5 to ·8 mm. high), stipe slender (·07 mm. thick), either all whitish or partly hyaline and partly fuscous, or all fuscous, or all black, sometimes furcate. Capitulum hemispherico lenticular, black, about ·25 mm. broad, sometimes divided into two or three or more lobes. Spores dilutely nigrescent, fusiformi ellipsoid, or oblong, compressed, simple, ·004 to ·006 × ·002 to 0025 mm., paries thick. Gel. hym. with iodine vinous yellow.

Hab. on dead bark of living eucalyptus, Cunninghame, Maffra, Beechworth.

Perhaps a variety of *C. pusiolum*, Ach.

4. *C. Victoriæ*, C. Knight.

Thallus white or whitish, or cinerascent, more or less marked, effuse. Apothecia all black, ·5 to 1 mm. high, stipe slender (·1 mm. thick) and a little thicker at the base. Capitulum turbinato lenticular or hemispherico lenticular, ·25 to ·5 mm. broad. Spores fuscous or fuscescent, fusiformi ellipsoid, compressed, simple, ·005 to ·008 × ·002 to ·003 mm., when viewed from the side bacillar, ·0015 mm. wide; paries thick, defined by a dark line on the outside.

Hab. on decaying decorticated eucalyptus, Croydon, Kew, Warrnambool, Warragul, Black Spur, Lakes Entrance, Mt. William, Tallarook, Mt. Macedon, Beechworth; frequent.

Allied to *C. parietinum*. Somewhat variable. *C. jejunum* reported by me (Trans. Lin. Soc. 1890), is now judged by me to be a not clearly marked form of *C. Victoriæ*.

5. *C. parvulum*, Wilson.

Thallus white or whitish, sub-determinate. Apothecia all black, ·4 mm. high, stipe slender (·05 mm. thick). Capitulum lenticular, ·16 mm. broad. Spores dilutely nigrescent, ellipsoid, simple, ·003 to ·006 × ·0015 to ·0025 mm., paries thin, black.

Hab. on decorticate eucalyptus, Maffra, Mt. Macedon, Beechworth.

The thallus looks like a thin coat of whitewash, on which the densely black apothecia, though very minute, are clearly visible. The outline of the spores is remarkable for its blackness, being in this respect like *C. Victoriæ*.

6. *C. contortum*, Wilson.

Thallus whitish, very thin. Apothecia all black, 1 mm. high, stipe ·1 mm. thick, contorted. Capitulum hemispherico lenticular. Spores dilutely nigrescent, fusiformi ellipsoid, simple, ·004 × ·0014 to ·002 mm.

Hab. on decorticate decaying eucalyptus, Lakes Entrance.

Allied to *C. Victoriæ*, which it resembles in its apothecia, but the capitula are smaller, the spores also are smaller and narrower, and different in colour.

7. *C. gracillimum*, Wilson.

Thallus indicated by a whitish spot. Apothecia all black, small (·8 mm. high); stipe very slender (·06 mm. thick); capitulum minute (·1 mm. broad); turbinato lenticular. Spores more or less dilutely nigrescent, ellipsoid or fusiformi ellipsoid, uniseptate, ·002 to ·004 × ·001 to ·002 mm., with a locule in each cell.

Hab. on decaying decorticated *Aster argyrophyllus*, Mt. Macedon.

The apothecia are extremely minute, being visible only under a powerful lens.

8. *C. deforme*, Wilson.

Thallus cinerascent, thin, granulose. Apothecia black, deformed by thalline and other granules, 1 mm. high, or a little more; stipe ·2 mm. thick; capitulum turbinato lenticular, to ·5 mm. broad. Sporal mass black, protruding, sometimes extending far on one side. Spores nigrescent, fusiformi ellipsoid, uniseptate, septum often indistinct, ·006 to ·008 × ·0025 to ·004 mm.

Hab. on decaying decorticated eucalyptus, Lakes Entrance. The apothecia have a deformed appearance, unlike the ordinary neatness of the genus. Its surface seems to be glutinous, readily retaining any granules or other particles that fall on it.

9. *C. roseo-albidum*, Wilson.

Thallus rosy-whitish, thick, minutely cancellate, chrysogonimic. Apothecia minute (·7 mm. high), all black; stipe slender (·06 mm. thick); capitulum lenticular (·2 mm. broad). Spores nigrescent, oblong or oblongo ellipsoid, apices rotundate, uniseptate, ·005 or more × ·002 to ·003 mm.

Hab. on decayed decorticated eucalyptus, Maffra, Kilmore. The thallus covers a good part of the tree, and when bruised, it becomes a deep yellow.

10. *C. capillare*, Wilson.

Thallus white, thin, or very thin. Apothecia all black, ·1 mm. high; stipe slender (·1 mm. thick); capitulum turbinato lenticular, ·3 to ·4 mm. broad. Spores nigrescent, oblong or ellipsoid, uniseptate, ·005 × ·0025 mm.

Hab. on decaying decorticated eucalyptus, Mt. Macedon, Warburton, Maffra.

Perhaps a variety of *C. subtile*, Pers., of which I reported it a variety (Trans. Lin. Soc., 1890).

11. *C. biloculare*, Wilson.

Thallus whitish or cinerascent, thin. Apothecia, all black, ·8 to ·1 mm. high; stipe, ·1 mm. thick; capitulum lenticular or sub-turbinato lenticular, ·3 to ·4 mm. broad. Spores fuscescent or fusco nigrescent, ellipsoid, or sub-fusiformi ellipsoid, bilocular or obsoletely bilocular or simple, with septum not visible, epispore thickish, ·005 to ·008 × ·002 to ·0035 mm.

Hab. on decaying decorticated eucalyptus, Warrnambool, Maffra, Bright.

Perhaps a variety of *C. subtile*, Pers., of which I reported it a variety (Trans. Lin. Soc., 1890).

12. *C. obovatum*, Wilson.

Thallus cinerascent, thin. Apothecia black, to ·8 or 1 mm. high; stipe to ·08 or ·1 mm. thick; capitulum obovate or turbinate, ·2 to ·3 mm. broad. Spores nigrescent, ellipsoid, uniseptate, each cell containing a globular locule, septum not always visible, ·005 to ·012 × ·003 to ·004 mm.

Hab. on eucalyptus wood in mountain regions, Mt. Macedon.

Distinct by the obovate capitulum.

13. *C. piperatum*, Wilson.

Thallus albido cinerascent or cinereous, thin. Apothecia black, sub-sessile, ·2 mm. high; stipe thick (·1 mm.); capitulum lenticular, disk plane, ·25 mm. broad. Spores fusco nigrescent, oblong, uniseptate, each cell containing a globular locule, ·004 to ·008 × ·0025 to ·005 mm.

Hab. on eucalyptus wood, both trees and fences, common, Mt. Macedon, Kilmore, Beechworth.

14. *C. nigrum*, Schær var. *minutum*, Knight.

Thallus obscurely cinerascent, granulose. Apothecia all black, small (·5 mm. high); stipe thick (·1 to ·12 mm.); capitulum turbinato cylindrical, disk pruinose, ·3 to ·7 mm. broad. Spores nigrescent, ellipsoid, uniseptate, constricted in the middle, each cell containing a globular locule, ·004 to ·012 × ·002 to ·006 mm.

Hab. on the horizontal surface of decaying eucalyptus fences, Kew, Maffra, Oakleigh.

15. *C. quercinum*, Pers. var. *bulbosum*, Wilson.

Thallus albido cinerascent. Apothecia to ·1 mm. high; stipe to ·2 mm. thick, capitulum globose, ·5 mm. diam., cinereo pruinose beneath. Spores fusco nigrescent, subfusiformi ellipsoid, ·006 to ·012 × ·003 to ·005 mm., uniseptate, septum often indistinct, cells containing each a nigrescent locule, epispore distinct, rubescent.

Hab. on decaying decorticated eucalyptus, Mt. Macedon.

Reported by me (Trans. Lin. Soc.) as *C. bulbosum*, and perhaps a variety of *C. quercinum*.

Var. 2. *microcarpum*, Wilson.—Thallus cinereous. Apothecia small, ·3 to ·4 mm. high; stipe black, ·1 to ·2 mm. high, ·05 to ·1 mm. thick; capitulum turbinate, disk flat, ·1 to ·2 mm. broad, margin cinerascent or albido cinerascent. Spores fuscescent, 1 septate, paries thick, constricted in middle; apices rather acuminate, ·008 × ·003 mm.

Hab. on decaying eucalyptus stump, near Tallarook.

Var. 3. *Clarensis*, Wilson.—Thallus whitish or cinerascent, of medium thickness. Apothecia black, ·8 mm. high, stipe ·1 mm. thick, capitulum ·3 mm. broad, turbinato lenticular, margin whitish. Spores fuscous or fuscescent, ellipsoid, narrow at apices, often constricted in middle, uniseptate or bilocular, ·005 to ·008 × ·002 to ·0035 mm.

Hab. on decaying decorticated eucalyptus, Bright, Beechworth.

16. *C. curtum*, Borr.

Thallus whitish, thin or evanescent. Apothecia to 1·8 mm. high, but often much less, stipe to ·2 mm. thick, capitulum turbinate, to ·6 mm. broad, albo suffused beneath. Sporal mass black, protruded upwards. Spores nigricant, ellipsoid, uniseptate, ·005 to ·01 × ·002 to ·003 mm.

Hab. on decaying decorticated eucalyptus and old hardwood fences, frequent and abundant, Lorne, Mt. Macedon, Oakleigh, Black Spur, Maffra, Bright, Mordialloc.

17. *C. trachelinum*, Ach. var. *elattosporum*, Wilson.

Thallus obscurely cinerascent or albescent. Apothecia very various in size, to 2 mm. high; stipe at the base ·25 mm. thick; capitulum globose or turbinate, to ·5 mm. broad, rufous at margin and upper part of stipe and even the disk. Spores ·003 to ·008 × ·002 to ·004 mm.

Hab. on decaying decorticated eucalyptus and fences, Cobden, Warburton, Warragul, Maffra, Lorne, Cunninghame.

The dimensions of the spores are half of those described by Nylander. This is in Victoria the commonest species of this genus, and often grows in large patches on the trees, covering many square feet with abundant apothecia, sometimes making the tree seem as though clothed with short hair.

Var. 2. *meiocarpum*, Wilson.—Thallus whitish, thin. Apothecia small, about ·8 mm. high; stipe about ·1 mm. thick; capitulum turbinato lenticular ·3 mm. broad; margin and upper part of stipe rufous. Spores fuscescent, ellipsoid, constricted in middle, uniseptate, with minute loculi in each cell, ·006 to ·007 × ·003 mm.

Hab. on decorticated lightwood tree, Kilmore.

18. *C. aurigerum*, Wilson.

Thallus white or whitish, somewhat thick. Apothecia small, stipe black ·2 to ·8 mm. high, ·05 to ·1 mm. thick; capitulum wholly covered with flavescent powder, lenticular, ·4 mm. broad. Spores nigrescent or fuscous, ellipsoid, uniseptate, rather constricted in middle, containing a locule in each cell, ·005 to ·007 × ·002 to ·004 mm.

Hab. on decaying eucalyptus wood, Mt. Macedon.

Possibly only a variety of *C. roscidum.*

19. *C. roscidum,* Flk. var. *eucalypti,* Wilson.

Thallus cinerascent, here and there flavo sorediose and then sterile. Apothecia to 1·3 mm. high, stipe black, ·1 mm. thick; capitulum turbinate, beneath more or less flavo virescent, to ·3 mm. broad. Spores fuscescent or more or less dilutely nigrescent, defined by a black line, ellipsoid, narrow at each apex, often constricted at middle, uniseptate, containing a paler locule in each cell, ·005 to ·009 × ·003 to ·005 mm.

Hab. on dead bark and decaying wood of eucalypti, Beechworth, Mt. Macedon.

20. *C. roscidulum,* Nyl.

Thallus white, thick, here and there rufescent (query alien ?). Apothecia ·9 mm. high, stipe ·1 mm. thick; capitulum turbinato lenticular, ·4 mm. broad; margin and upper part of stipe golden green. Spores fuscescent, ellipsoid, constricted at middle, uniseptate, ·003 to ·006 × ·002 to ·003 mm.

Hab. on decayed eucalyptus stump, Kilmore.

Probably a mere variety of *C. roscidum.*

21. *C. hyperellum*, Ach.

Thallus flavo virescent, granulose or sub-leprose. Apothecia black; capitulum globoso-lentiform; stipe black, elongate; sporal mass black or umber black. Spores nigrescent, ellipsoid, uniseptate, ·009 to ·016 × ·004 to ·006 mm. (Nyl.)

Hab. on bark of trees. B. v. M., *Vic. Nat.*, Oct. 1877, p. 89.

Var. *validius*, C. Knight.—Thallus yellow or sulphureo cinerascent, thickish, verrucoso unequal. Apothecia all black; stipe short and thick (to ·5 mm. high, ·3 mm. thick); capitulum turbinato lenticular, disk lecideine, to ·5 mm. broad. Spores fuscous, ellipsoid, sub-acuminate at each apex, somewhat constricted in the middle, uniseptate, ·007 to ·013 × ·003 to ·006 mm.

Hab. on wood and decorticated decaying trunks of eucalyptus, Maffra, Lakes Entrance, Bright, Beechworth.

Var. 2. *perbreve*, Wilson.—Thallus flavo virescent, crustaceous, rugose. Apothecia very short, nearly sessile. Sporal mass black, protruded horizontally until the apothecia are often conjoined. Spores fusco nigrescent, ellipsoid, often narrower at each apex, somewhat constricted in the middle, uniseptate, ·007 to ·015 × ·003 to ·0075 mm.

Hab. on decaying eucalyptus wood, Maffra.

22. *C. tricolor*, Wilson.

Thallus sulphureous, leproso granulose. Apothecia black, small (to ·75 mm. high); stipe 1 mm. thick; capitulum turbinato globose, ·2 to ·5 mm. broad, margin white. Spores fuscous, fusiformi ellipsoid, sub-acuminate at each apex, somewhat constricted in the middle, uniseptate, with a fusco nigrescent locule in each cell, ·008 to ·012 × ·003 to ·005 mm.

Hab. on decaying decorticated eucalyptus, Warrnambool, Lakes Entrance.

23. *C. flavidum*, Wilson.

Thallus yellow or sulphureous, crustaceous, smooth, nearly shining. Apothecia black, but with margin, and often the stipe tinged with the thalline colour, 1 mm. high; stipe 5 mm. thick, tapering downwards; capitulum globoso turbinate. Sporal mass black, protruded. Spores fusco

nigrescent, ovoid or sub-fusiformi ellipsoid, uniseptate, epispore rubescent, cells fuscescent, containing each one or two nigrescent locules, ·008 to ·01 × ·003 to ·004.

Hab. on decorticated eucalyptus, Lakes Entrance.

GENUS 3.—CONIOCYBE, Ach. Nyl.

Thallus leprose or powdery, effuse or evanescent. Apothecia yellow or pale, not black, stipitate, excipulum very open. Spores usually spherical, colourless or flavescent, forming the globoso pulverulent capitulum.

1. *C. citriocephala*, Wilson.

Thallus white, thin. Apothecia minute; stipe black, slender, 1 mm. high, ·06 thick, often less. Capitulum flavo virescent, turbinate, at length globose, to ·2 mm. diameter, becoming fuscous and turbinate when stripped of the sporal mass. Spores colourless or dilutely flavid, briefly oblongo ellipsoid or spheroidal, ·02 to ·04 × ·02 to ·03 mm.

Hab. on dead wood and dead bark of trees, Lakes Entrance.

2. *C. ochrocephala*, Wilson.

Thallus whitish, often with green leprose granules. Apothecia with slender fuscous stipe, ·6 to 1·2 mm. high, ·06 to ·08 mm. thick, often bifurcate; capitulum globose, pale ochre, ·25 mm. diameter. Spores colourless or dilutely fuscescent, globose, ·002 to ·003 mm. diameter, containing a central locule.

Hab. on decaying decorticated Aster argyrophyllus, Senecio bedfordii, and eucalyptus, Mt. Macedon and Korumburra.

3. *C. rhodocephala*, Wilson.

Thallus white or whitish or cinerascent or cinereous or evanescent. Apothecia often caspitoso congested; stipe scarlet or hyaline, at length fuscous or black and pruinose, contorted and compressed, to 2 mm. high, ·2 mm. thick, sometimes furcate or two partly coalescent. Capitulum globose, obscurely rufous or fuscous, at length rose or flesh colour, pruinose, rarely albid, ·4 to ·8 mm. diameter. Spores very numerous,

colourless, ellipsoid or ovate ·003 to ·006 × ·0015 to ·004 mm., bilocular or placodine or uniseptate, with a locule in each cell, epispore thick. Paraphyses numerous, distinct.

Hab. on dead wood or bark of tree, Lakes Entrance.

This species is remarkable for the form of its spores. All the genus hitherto described hăve spherical simple spores.

The var. *rubens* reported by me (Trans. Lin. Soc.), having been since found in larger quantity, proves to be scarcely more than a juvenile form.

4. *C. gracilenta,* Ach. var. *leucocephala,* Wilson.

Thallus green, conglomerato leprose. Apothecia with stipe long and tender (1·5 to 2·5 × ·1 mm.), fusco nigricant, opaque, and capitulum small, sporal mass white, irregularly clothing the capitulum and the upper part of the stipe. Spores colourless, minute, sphæroidal, ·002 to ·003 mm. diameter.

Hab. on earth, Fernshawe, Mrs. Martin, March 1891.

GENUS 4.—TRACHYLIA, Fr. pr. p. Nyl.

Thallus thin, granulose or subleprose, or foreign. Apothecia black, sessile, cupuliform, open, sporal mass black. Spores nigricant or fuscous black, ellipsoid or oblong, uniseptate, rarely pluriseptate.

1. *T. lecanorina,* Wilson.

Thallus cinerascent, verruculoso leprose, passim verrucoso sorediate, gonidia moderate and abundant. Apothecia small (to ·5 mm. broad), crowded, elevated in thalline receptacles. Sporal mass black, abundant, often much protruded and connecting the apothecia Spores fusco nigricant or nigrescent, or nearly colourless, ellipsoid, uniseptate, ·01 to ·02 × ·006 to ·01 mm.

Hab. on old eucalyptus fences, Cheltenham, Yalla-y-poora, near Streatham.

This plant bears at first sight a great resemblance to *Lecanora atra.*

2. *T. viridilocularis,* Wilson.

Thallus obscurely cinerascent. Apothecia black, somewhat elevated, ·3 mm. high, ·3 mm. broad. Sporal mass

abundant. Spores nigricant or virescenti nigricant, irregularly ellipsoid, uniseptate, ·01 to ·02 × ·008 to ·01 mm., with one or rarely two locules in each cell.

Hab. on sawn eucalyptus rails, Kew.

This lichen is associated with *Calicium nigarum*, var. *minutum*, the *Calicium* on the more decayed horizontal face of the squared rail, and the *Trachylia* on the perpendicular face. The spores are tinged bottle green.

3. *T. emergens*, Wilson.

Thallus white or whitish, thin, smooth, somewhat shining. Apothecia seem to emerge from among the fibres of the wood, and at length barely stand out above the thallus, to ·5 mm. broad. Spores fusco nigricant, adhering closely together, ellipsoid, about ·005 × ·003 mm., but very various in size, uniseptate, with a locule in each cell.

Hab. on eucalyptus rails in sub-Alpine regions, Mount Macedon. Found also on Mount Lofty, in South Australia, and Mount Wellington, in Tasmania.

4. *T. Victoriana*, Wilson.

Thallus cinerascent, thin, effuse. Apothecia typically sessile, but often very briefly stipitate, to ·4 mm., high, disk generally sulphureo pruinose, to ·4 mm. broad. Spores fuscous, oblongo ellipsoid, ·005 to ·006 × ·003 to ·004 mm., uniseptate, with a nigrescent locule in each cell.

Hab. on old eucalyptus rails. The fuscous epispore readily rubs off, leaving the spore nigrescent, ellipsoid, narrow at each apex, and smaller, ·004 to ·005 × ·002 to ·003 mm.

5. *T. exigua*, Wilson.

T. exigua, Wilson (Trans. Lin. Soc., 1890) on further examination proves not to be a *Trachylia*.

TRIBE 2.—SPHÆROPHOREI.

Thallus fruticulose, ramose and ramulose, the apices subgloboso-incrassate, enclosing the apothecia, which are nucleiform, enclosed, ultimately exposed by the bursting of the thalline covering.

GENUS 1.—SPHÆROPHORON, Pers.

Thallus cæspitoso fruticulose, smooth, polished, fragile. Apothecia in the apices of the thallus, receptacle irregularly dehiscent. Spores nigricant or violaceo nigricant, spherical or sub-globose, covered with a black powder.

1. *S. australe*, Laur. = *S. ceranoides*, Hampe.

Thallus to 2 inches long, pallid, ramose, branches compressed, explanate, often distichously ramulose, beneath albicant, rugose. Receptacle ·6 to ·12 mm. broad, lenticulari compressed, external margin above cristato crenate. Spores ·011 to ·015 mm. diam.

Hab. Sealer's Cove, by Dr. F. Mueller; Moe; *S. ceranoides*, Hampe, in Linnæa (1856), XXVIII, p. 217; *S. australe*, Müll. Lich. Beitr., XVII, p. 1; B. v. M., *Vic. Nat.*, 1887, p. 89.

Var. *proliferum*, Wilson.—Thallus cæruleo pallid on upper surface, convex, smooth, nearly shining, under surface white, fossulato canaliculate or scrobiculato unequal, to 3 inches long, sub-pinnatifid, branches linear, 2 to 7 mm., broad, variously divided. Apothecia on the under surface of the thallus, the margin branching and proliferous once or twice.

Hab. on the trunks of large trees in shady woods, Black Spur, Warburton.

The plant grows horizontally from the tree, then droops downwards, and then bends gracefully upwards, displaying the apothecia on the under side of the thallus. The proliferous branches grow, one or more, from the margin of the apothecium.

2. *S. compressum*, Ach.

Thallus pallido albicant, ramose, plano compressed. Apothecia obliquely minute on the apices; receptacle lacero dehiscent, or discoid and open. Spores nigricant, spherical, ·007 to ·011 mm. diam. (Nyl.)

B. v. M., *Vic. Nat.*, Oct. 1887, p. 89.

3. *S. coralloides*, Pers.

Kremp., in *Verhand. Zool. Botan. Gesellsch.*, in Wien, 1880, p. 329. A mistake for *Stereocaulon ramulosum*, according to Prof. J. Mueller, in *Ratisbon Flora*, 1887, No. 8.

4. *S. tenerum*, Laur.

Thallus pale or whitish, terete, slender, very much branched, branches fine and intricate. Apothecia small (·1 to ·2 mm.) on the primary branches; thalline receptacle persistent, only slightly dilated. Spores nigricant, or smeared with a friable nigricant pigment. Diam. ·007 to ·008 mm. (Nyl.)

Kremp., in *Verhandl. Zool. Bot. Gesells.*, in Wien, 1880, p. 329. According to Prof. J. Mueller (in *Ratisbon Flora*, 1887, No. 8), a specimen from Mt. Ellery is rightly determined, but specimens from Black Spur and Yarra Yarra are *Cladina aggregata.*

SERIES 2.—CLADODEI.

Thallus generally erect. Apothecia terminal on podetia, rarely sessile; biatorine, rarely lecanorine. Spores 8, colourless, usually oblong and simple, sometimes elongate and septate. Paraphyses distinct.

TRIBE 3.—BÆOMYCEI.

Thallus horizontally expanded, crustaceous. Apothecia pale or rufescent, sessile or podetiiformi stipitate. Spores simple or septate.

GENUS 1.—GOMPHILLUS, Nyl.

Thallus very thin, consisting of gonidia and filaments irregularly conglutinated. Apothecia stipitate, small, corneous. Spores filiform, multiseptate. Paraphyses indistinct.

1. *G. bæomyceoides*, Wilson = *Patellaria Wilsoni*, Mull. Arg.*

Thallus cinereous or virescent, effuse, either very thin and somewhat shining, or rather thicker and eroso isidioso granulate. Gonidia various in size and form, conglomerated into gelatinous globules. Apothecia of a tenacious horny texture, biatorine, sometimes margined by the white hypothecium, scattered or conglomerated, depresso globose, to 1·5 mm. diam., smooth, rufo fulvescent, pale when young,

* Lich. Beitr., in Flora 1888, No. 1435.

and dark in age, sub-sessile or stipitate, stipe to ·5 mm. high and ·5 mm. thick, with sometimes two or three capitula on one stipe. Spores, eight in cylindrical thecæ, aciculari filiform, about ·14 mm. long, pluriseptate.

Hab. on roots and trunks of trees, upon mosses and bark, and jungermannias and lichens; also on the earth upon dead leaves, &c., in shady mountain forests, Black Spur, Mt. Macedon, Warragul.

GENUS 2.—BÆOMYCES, Pers.

Thallus crustaceous, powdery, granulose or squamulose. Apothecia biatorine, sessile or stipitate.

1. *B. rufus*, D. C.

Thallus albo virescent or albido glaucescent, thin, effuse, minutely granulose or squamulose or leprose, granules depressed (K yellow). Apothecia carneo rufescent or carneo fuscescent, somewhat convex, immarginate, stipe moderate or very short, whitish. Spores, 6 or 8, oblongo ellipsoid, simple.

B. v. M., *Vic. Nat.*, Oct. 1887, p. 89.

2. *B. fusco carnea*, Wilson.

Thallus pallid, granuloso verrucose, granules sometimes depressed. Apothecia rufo fuscescent, quasi pruinose, 1 to 2 mm. broad, convex, margined by the hypothecium. Stipe white, nude, short (less than 1 mm. high). K. thal. and apoth. yellow, then blood red. Spores ellipsoid, simple, ·008 to ·01 × ·003 to ·005 mm.

Hab. on clay ground, Kilmore.

3. *B. roseus*, Pers.

Thallus whitish, granulose, effuse or determinate. Apothecia roseo carneous, or albo carneous, nearly globose, about 2 mm. broad, stipe whiter or nearly white, subterete. Spores six or eight, fusiformi oblong or fusiform, simple, ·011 to ·026 × ·0025 to ·003 (Nyl.) Paraphyses slender.

Hab. on bare earth, chiefly clay. B. v. M., *Vic. Nat.*, Oct. 1887, p. 89.

(See note on next species.)

4. *B. fungoides*, Ach.

Thallus whitish, granulose, margin of granules spreading, thin, continuous. Apothecia roseo carneous or albo carneous, sub-globose, or globoso clavate, or difformi clavate, moderate or large (2 to 4 mm. broad); stipe long (4 to 8 mm.), whiter or nearly white, subterete. Spores oblong or fusiform, simple, ·011 to ·023 × ·0035 mm. Paraphyses slender.

Hab. on earth, chiefly clay, in mountain regions, Otway Ranges, Black Spur, Warburton, Mt. Lookout, (A. F. Wilson).

Probably a variety of *B. roseus*, growing in a warmer climate, as Tuckerman suggests. When not well developed it approaches the previous species.

5. *B. heteromorphus*, Nyl.

Thallus pallido glaucescent or pallido cinerascent, verrucoso unequal, forming large patches. Apothecia pale carneous, or carneo fuscescent, ·5 to 1 mm. broad, margin thick, undulate, obtuse, stipe 1 to 2·5 mm. high, variously compressed or plicate, often two to six or more apothecia on one stipe. Spores very transparent, nearly indistinct, ellipsoid, simple, ·01 × ·006 mm. Thall. and Apoth. K.+C—.

Hab. on clay ground, mosses, dead leaves, &c., in mountain regions, Black Spur, Mt. Macedon, Warburton, Otway Ranges, Lilydale, Mt. Buffalo (A. F. Wilson).

6. *B. squamarioides*, Nyl. = *Knightiella leucocarpa* = *K. squamarioides*, Mull. Arg.

Thallus albo or albido glaucescent, subopaque, squamose, squamæ difformed, about ·5 mm. broad, affixed (forming small patches about an inch wide), lobate or lobato incised, plane or somewhat depressed in the centre, concolorous beneath or whiter. Apothecia lurid or pale lurid or lurido carneus, ·2 to ·3 mm. broad, biatorine, plane, margin thickish, evanescent. Spores oblong or fusiformi oblong, uniseptate.

Hab. on earth, Mt. William (D. Sullivan). Mull. Lich. Beitr., 1888, No. 13, p. 8.

7. *B. Frenchianus*, Mull. Arg.

Thallus squamose; squamæ cæspitose, crowded, broad, inciso lobate; lobes ascending, crenulate or entire, olivaceous above, white beneath, bearing podetia here and there upon

Hab. on decaying decorticated eucalyptus, Mt. Macedon.

Reported by me (Trans. Lin. Soc.) as *C. bulbosum*, and perhaps a variety of *C. quercinum*.

Var. 2. *microcarpum*, Wilson.—Thallus cinereous. Apothecia small, ·3 to ·4 mm. high; stipe black, ·1 to ·2 mm. high, ·05 to ·1 mm. thick; capitulum turbinate, disk flat, ·1 to ·2 mm. broad, margin cinerascent or albido cinerascent. Spores fuscescent, 1 septate, paries thick, constricted in middle; apices rather acuminate, ·008 × ·003 mm.

Hab. on decaying eucalyptus stump, near Tallarook.

Var. 3. *Clarensis*, Wilson.—Thallus whitish or cinerascent, of medium thickness. Apothecia black, ·8 mm. high, stipe ·1 mm. thick, capitulum ·3 mm. broad, turbinato lenticular, margin whitish. Spores fuscous or fuscescent, ellipsoid, narrow at apices, often constricted in middle, uniseptate or bilocular, ·005 to ·008 × ·002 to ·0035 mm.

Hab. on decaying decorticated eucalyptus, Bright, Beechworth.

16. *C. curtum*, Borr.

Thallus whitish, thin or evanescent. Apothecia to 1·8 mm. high, but often much less, stipe to ·2 mm. thick, capitulum turbinate, to ·6 mm. broad, albo suffused beneath. Sporal mass black, protruded upwards. Spores nigricant, ellipsoid, uniseptate, ·005 to ·01 × ·002 to ·003 mm.

Hab. on decaying decorticated eucalyptus and old hardwood fences, frequent and abundant, Lorne, Mt. Macedon, Oakleigh, Black Spur, Maffra, Bright, Mordialloc.

17. *C. trachelinum*, Ach. var. *elattosporum*, Wilson.

Thallus obscurely cinerascent or albescent. Apothecia very various in size, to 2 mm. high; stipe at the base ·25 mm. thick; capitulum globose or turbinate, to ·5 mm. broad, rufous at margin and upper part of stipe and even the disk. Spores ·003 to ·008 × ·002 to ·004 mm.

Hab. on decaying decorticated eucalyptus and fences, Cobden, Warburton, Warragul, Maffra, Lorne, Cunninghame.

The dimensions of the spores are half of those described by Nylander. This is in Victoria the commonest species of this genus, and often grows in large patches on the trees, covering many square feet with abundant apothecia, sometimes making the tree seem as though clothed with short hair.

Var. 2. *meiocarpum*, Wilson.—Thallus whitish, thin. Apothecia small, about ·8 mm. high; stipe about ·1 mm. thick; capitulum turbinato lenticular ·3 mm. broad; margin and upper part of stipe rufous. Spores fuscescent, ellipsoid, constricted in middle, uniseptate, with minute loculi in each cell, ·006 to ·007 × ·003 mm.

Hab. on decorticated lightwood tree, Kilmore.

18. *C. aurigerum*, Wilson.

Thallus white or whitish, somewhat thick. Apothecia small, stipe black ·2 to ·8 mm. high, ·05 to ·1 mm. thick; capitulum wholly covered with flavescent powder, lenticular, ·4 mm. broad. Spores nigrescent or fuscous, ellipsoid, uniseptate, rather constricted in middle, containing a locule in each cell, ·005 to ·007 × ·002 to ·004 mm.

Hab. on decaying eucalyptus wood, Mt. Macedon.

Possibly only a variety of *C. roscidum.*

19. *C. roscidum,* Flk. var. *eucalypti,* Wilson.

Thallus cinerascent, here and there flavo sorediose and then sterile. Apothecia to 1·3 mm. high, stipe black, ·1 mm. thick; capitulum turbinate, beneath more or less flavo virescent, to ·3 mm. broad. Spores fuscescent or more or less dilutely nigrescent, defined by a black line, ellipsoid, narrow at each apex, often constricted at middle, uniseptate, containing a paler locule in each cell, ·005 to ·009 × ·003 to ·005 mm.

Hab. on dead bark and decaying wood of eucalypti, Beechworth, Mt. Macedon.

20. *C. roscidulum,* Nyl.

Thallus white, thick, here and there rufescent (query alien ?). Apothecia ·9 mm. high, stipe ·1 mm. thick; capitulum turbinato lenticular, ·4 mm. broad; margin and upper part of stipe golden green. Spores fuscescent, ellipsoid, constricted at middle, uniseptate, ·003 to ·006 × ·002 to ·003 mm.

Hab. on decayed eucalyptus stump, Kilmore.

Probably a mere variety of *C. roscidum.*

Art. XIII.—*On a New Species of Leucosolenia from the neighbourhood of Port Phillip Heads.*

By Arthur Dendy, D. Sc.

[Read December 8, 1892.]

The species here described was collected by Mr. J. Bracebridge Wilson, M.A., in the neighbourhood of Port Phillip Heads, but unfortunately too late for it to be included in Part I of the Monograph of the Victorian Sponges, which deals with the group (Homocœla) to which it belongs.

Leucosolenia uteoides, n. sp.

In external form and canal system the sponge very closely resembles *Leucosolenia stolonifer*, Dendy,* belonging, like the latter, to the section of the genus *Leucosolenia* to which I have proposed to apply the name *Simplicia*. The single specimen is colonial, consisting of about one hundred individuals united together by their bases only and rising vertically upwards side by side so as to form a compact colony. The spongorhiza is not conspicuous, being represented by the union of the various individuals at their bases. From the basal portions of the individuals, thus united, arise numerous short, slender, downward-growing, tubular processes, which apparently serve, as in *L. stolonifer*, to attach the colony to the substratum. The fully developed Ascon individuals attain a height of about 35 mm. and a diameter of about 2·5 mm. Each is a nearly straight, slender, cylindrical, thin-walled tube, narrowing slightly towards the naked, terminal osculum. The tubes may branch, especially near their bases. Under a lens the outer surface of each tube appears very slightly hispid and also exhibits that longitudinal striation, due to the presence of large oxeote spicules, which is so characteristic of the genus

* "Monograph of the Victorian Sponges," Part I, p. 46. Plate I, Fig. 2.

Ute, whence the specific name *uteoides*. The wall of the tube is about 0·13 mm. thick, the mesoderm being, as in *L. stolonifer*, very strongly developed for a Homocœl sponge.

The skeleton consists of quadriradiate and two kinds of oxeote spicules. The quadriradiates are arranged as usual in the thickness of the mesoderm towards the inside of the sponge-wall, the facial rays lying parallel to the gastral surface, the basal ray directed away from the osculum, and the apical ray projecting into the gastral cavity. These spicules are markedly sagittal, the oral rays being widely extended and distinctly recurved towards the basal. All three facial rays are long and slender, but the basal is much more so than the orals and is slightly hastate; all three are fairly sharply pointed. In an average-sized spicule the oral rays measure about 0·186 by 0·0082 mm. (near the base) and the basal about 0·31 by 0·006 mm. (near the base), but of course there is a good deal of variation, and I have measured the basal ray up to 0·42 mm. in length. The apical rays are very strongly developed; long, slender and sharply pointed; usually more or less crooked and varying greatly in length; the average length is perhaps about 0·15 mm., but this is often greatly exceeded.

The oxeote spicules may be divided into two classes according to their shape, size and position in the sponge. (1) Very large spindle-shaped oxea, completely imbedded in the outer portion of the sponge wall and arranged parallel to the long axis of the sponge. These spicules are usually straight and symmetrically fusiform, very thick in the centre and tapering gradually to a fine point at each end. Fully grown examples measure a little over 1 mm. in length and about 0·065 mm. in greatest thickness (in the centre). They are placed pretty close together side by side in a single layer. (2) Much smaller oxea projecting from between the large ones and abundantly echinating the outer surface of the sponge. These spicules are rather slender, often slightly curved or even crooked, fairly gradually sharp-pointed at each end, but with the outer end often bent slightly though sharply to one side, like a bayonet; size about 0·22 mm. by 0·008 mm. The colour of the sponge in spirit is yellowish-white.

As already pointed out this species is nearly related to my *Leucosolenia stolonifer*, but it appears to be even more

nearly related to Carter's *L. asconoides,** with which it agrees not only in general form but also in the *Ute*-like armour of huge spindle-shaped oxea. In *L. asconoides*, however, there appear to be none of the smaller oxea which so abundantly echinate the dermal surface of our species, while the large oxea are nearly twice the size of those of *L. uteoides.* It is a curious fact that in *L. asconoides*, "more or less of the arms" of the quadriradiates are "exserted between the long acerates, so as to give this part a minutely hispid appearance. At first sight the latter look like mortar-spicules or small acerates, but although they appear to serve the same purpose, they are *not* so, but what I have stated."† In view of this very definite statement it appears tolerably certain that *L. uteoides* is specifically distinct from *L. asconoides.*

* *Vide*, "Monograph of Victorian Sponges," Part I, p. 48.

† Carter, "Annals and Magazine of Natural History," August 1886, p. 135.

ART. XIV.—*The Present Position of the Snake-bite Controversy.*

By JAMES W. BARRETT, M.D., M.S., F.R.C.S. Eng.

Demonstrator and Examiner in Physiology in the University of Melbourne.

[Read November 10, 1892.]

The public and the technical press have of late been occupied with discussions on the merit or demerit of the so-called strychnine cure for snake-bite, but as usual, very little definite evidence has been adduced. I have, therefore, thought it advisable to bring the facts of the case under the notice of the members of this Society, so that the position occupied by the rival disputants may be rendered perfectly clear. Dr. Mueller of Yackandandah, it seems, has satisfied himself that a theory respecting the action of snake poison has been proved. He believes that strychnia is consequently indicated as a remedy. When, however, he is asked to substantiate both these propositions, by showing that the treatment is successful, he has no further evidence to adduce than the report of cases of snake-bite, real or supposed, in which medical men assert that patients were saved from death by the injection of strychnine. Now, it is obvious that before reports of such cases can be of much value, it is necessary to ascertain the percentage of individuals who died from snake-bite when other modes of treatment were adopted. In other words, snake-bite is or is not a very fatal affection.

The object of this communication is to endeavour to make answer to that question. In investigating it, I have had

extensive recourse to tables, furnished to me by the ever obliging Government Statist, Mr. Hayter.

Table I, which follows, shows the deaths which have taken place from snake and insect bite (for the two are bracketed in returns together) in the Australian colonies during the decade 1881–1890. In accordance with the foot-note appended to this table, I have rejected from further consideration any deaths occurring in other colonies than Victoria, New South Wales, and Queensland. You will further note that of the total 125 deaths which occurred in these three colonies in the period mentioned, at least 5 or 6 are obviously due to bites of other animals than snakes. There is the further probability that some of the deaths have been caused by the enthusiastic administration of alcohol to persons bitten or supposed to be bitten. However, to be well within the mark, I assume that 125 deaths represent fatal cases of snake-bite, and proceed to deal with them accordingly.

TABLE I.

Deaths from Snake and Insect-bite in the Australian Colonies, 1881 *to* 1890.

YEARS.	Victoria.*	N. S. Wales.	Queensland.	South Australia†	West Australia†	Tasmania†	Total.
1881	5	5	5	..	..	1	16
1882	5	..	3	..	1	1	10
1883	2	4	..	..	..	1	7
1884	3	8	..	..	..	..	11
1885	3	3	3	..	1	..	10
1886	4	5	..	..	..	..	9
1887	9‡	3	8	..	..	1	21
1888	3	5	4	..	..	..	12
1889	2	4	11	1	..	..	18
1890	2	10	6	1	..	..	19
Total	38	47	40	2	2	4	133

NOTE.—There are no deaths from snake-bite in New Zealand.

In Victoria, in 1891, there were 5 deaths from snake-bite, and 1 from iguana-bite.

* In other years than 1881 and 1882, no distinction was regularly made in Victoria between snake and insect-bites. Two of the deaths in the former year, and 1 in the latter, were from insect-bite.

† In the case of these colonies, it is not certain whether there were any deaths in several of the years, as the cause was not specifically mentioned in the list of causes of death.

‡ One of these is distinguished as "vermin-bite" and 1 "insect-bite."

It will be seen that in this period, in the three colonies, snakes were unable to kill more than 125 persons.

In order to determine the relative frequency of death from snake-bite, I next append a table showing the population (actual and average) of the colonies during the same period.

TABLE II.

Mean Populations of the Australasian Colonies, 1881 *to* 1890.

YEAR.	Victoria.	N. S. Wales.	Queensland.	South Australia.	West Australia.	Tasmania.	New Zealand.*	Total Australasia.
1881	868,942	765,015	226,522	276,948	29,516	116,437	492,867	2,776,262
1882	889,720	798,540	237,611	289,916	30,389	119,473	509,308	2,874,957
1883	910,130	838,155	267,865	299,012	31,233	122,242	529,292	2,997,929
1884	932,630	883,145	294,782	308,648	32,329	125,352	548,993	3,125,879
1885	956,880	927,275	308,789	313,102	34,072	128,160	566,168	3,234,446
1886	981,860	969,455	327,034	311,254	37,184	130,441	582,306	3,342,735
1887	1,016,750	1,004,835	346,545	311,050	41,699	133,802	596,373	3,450,391
1888	1,054,980	1,035,705	361,230	312,253	42,312	137,167	605,370	3,549,017
1889	1,090,350	1,066,450	374,240	313,751	43,053	140,261	611,716	3,639,685
1890	1,118,500	1,101,840	385,805	316,425	47,950	143,733	620,780	3,734,685
Average	982,374	939,041	313,042	305,235	36,973	129,706	566,319	3,272,599

* Exclusive of Maoris.

Therefore, the proportion of fatal cases of snake-bite to the average number of persons alive during the period is shown by the following table, which gives :—

TABLE III.

The Ratio of Deaths from Snake-bite in each Colony during the Decade to the average Population.

Victoria - - - - -	1 to	25,852
New South Wales - - -	1 to	19,980
Queensland - - - -	1 to	7,826
Average - - - -	1 to	17,886

The death-rate from snake-bite in Queensland seems very much higher than in the other two colonies. The following

table will, however, show the danger of drawing rash conclusions from figures :—

TABLE IV.

Deaths from Violence in the Australian Colonies, 1881 *to* 1890.

YEARS.	Victoria.	N. S. Wales.	Queensland.	South Australia.	West Australia.	Tasmania.	New Zealand.	Total.
1881	849	906	317	233	36	105	459	2,905
1882	841	904	439	210	53	88	505	3,040
1883	908	850	396	202	59	106	494	3,015
1884	799	990	509	239	51	90	548	3,226
1885	846	1,106	492	212	45	92	517	3,310
1886	942	1,083	496	272	67	94	571	3,525
1887	1,023	1,148	599	229	57	112	555	3,723
1888	1,119	1,140	593	234	90	118	513	3,807
1889	1,186	1,110	622	203	44	144	508	3,822
1890	1,165	1,163	737	238	43	138	521	4,005
Total	9,678	10,400	5,200	2,277	545	1,087	5,191	34,378

TABLE V.

The Ratio of the Total Deaths from Snake-bite during the Decade to the Total Deaths from Violence.

Victoria	1	to	254·7
New South Wales	1	to	221·3
Queensland	1	to	130
Average	1	to	202

The following table shows the ratio of the total deaths from violence during the decade to the average population:—

TABLE VI.

Victoria	1	to	101·5
New South Wales	1	to	90·3
Queensland	1	to	61·2
Average	1	to	84·3

It will thus be seen that although the ratio of deaths from snake-bite to the average population, and also to the total deaths from violence, is higher in Queensland than in the other two colonies, the ratio of deaths from violence to the average population is also higher. Consequently it is unsafe to infer, from the evidence furnished, that snake-bite is necessarily a more fatal affection in Queensland than in the other colonies.

From this mass of figures we arrive at a general conclusion that snake-bite is one of the most insignificant causes of death in our midst. For example, in the three years 1887–88–89 more persons died in Victoria from hydatid disease than were killed by snakes in Australia during the decade. Anyone who cares to look through Mr. Hayter's tables will find that the snake-bite contribution is a very small one.

In 1876, a Committee was appointed by the Medical Society of Victoria which experimented in a methodical way. The Committee consisted of Drs. M'Crea (Chairman), T. M. Girdlestone, E. Barker, J. E. Neild, A. Bowen, P. Smith, J. T. Dempster, and Professor J. D. Kirkland. The particular value of the work done by this Committee lay in the fact that it found, with antidotes then in use, the recovery of a dog from snake virus injected hypodermically was chiefly a matter of dosage. None of the dogs used recovered when half a grain of fresh liquid poison was injected. They further found that tiger snakes 3 ft. to 4 ft. long injected on an average from 1 to 1½ grains of liquid poison, a quantity believed by analogy to be barely sufficient to kill a man. One grain of tiger snake venom, if injected fairly into the skin, would be approximately a dangerous dose. It is, however, quite possible that a snake driving its fangs through the skin finds it difficult to administer the full dose. If the snake bites through clothing, the chances of a fatal issue are diminished. On the other hand, in the case of some of the Indian snakes, allied in character to the Australian black and tiger snake, the dose of poison injected amounts to from 10 to 13 grains. Comment is needless.

Furthermore, Dr. M'Crea, in 1876, forwarded a circular to a number of medical practitioners asking them for information on the subject of snake-bite. In answer, he found that 253 cases of snake-bite had occurred in the practice of a number of medical practitioners, and that of these only 25, or 10 per cent., terminated fatally. Various methods of treatment had been adopted.

It seems, therefore, that fatal results from snake-bite are not common, and can scarcely take place unless the conditions are favourable to the snake. Nevertheless, if snake-bite were responsible for only one death in the decade, one would hail with pleasure the remedy which would obviate the repetition of such an accident; and my object in referring to these figures is not to under-rate the value of any remedy.

but to show the difficulty of being accurate in forming conclusions respecting its value.

These facts are so well-known that I must apologise for restating them. I have mentioned them in outline simply as part of the argument. In fact, if the name of other remedies used in the past be excised from old reports in the Journal, and the word strychnia be substituted, the description would parallel the present accounts of the efficacy of strychnia.

If, then, a discoverer of a snake-bite antidote has to refer to mortality tables as a proof of its success, he has a small margin to work on. He is dealing with a disease which is not usually intractable.

The public reports of cases may be referred to as evidence of its value, but apart from preceding facts altogether, I would ask anyone who is inclined to attach any value to such statements to think for a moment what they mean. Men, women, or children of different physiological resistance and vigour bitten, or supposed to be bitten, by snakes of different age, biological characters, and virus-producing capacity, the punctures made into skins of different thickness and in different parts of the body—treatment of various kinds adopted. Are there here not enough variables to cause grave doubt as to the value of a new variable introduced in the form of strychnia? Again, public reports of cases have been held to prove such extraordinary theories in medical history that one may be pardoned for receiving them with great caution. As stated, other remedies for snake-bite have been similarly commended at the hands of their demonstrators in the columns of the *Australian Medical Journal.*

There is one method by which the value of strychnia as a remedy may be settled, viz., by resort to experiments on animals on which the action of snake poison does not to all appearances differ materially from that in the case of man. From this, however, Dr. Mueller dissents, though he refers to experiments made on animals in support of his theory.

The evidence adduced serves to show that there is no warrant for believing strychnia to be of any value as an antidote for snake-bite; but there is no warrant for asserting that it is valueless. By the experimental method alone, can the vexed question be settled.

Art. XV.—*Sneezing: Fallacious Observations.*

By James W. Barrett, M.D., M.S., F.R.C.S. Eng.

Demonstrator and Examiner in Physiology in the University of Melbourne.

[Read December 8, 1892.]

In the last edition of "Foster's Physiology," there occur the following passages:—"Coughing consists in the first place of a deep and long-drawn inspiration, by which the lungs are well filled with air. This is followed by a complete closure of the glottis, and then comes the sudden forcible expiration, in the midst of which the glottis suddenly opens, and thus a blast of air is driven through the upper respiratory passages. The afferent impulses of this reflex act are in most cases, as when a foreign body is lodged in the larynx or by the side of the epiglottis, conveyed by the superior laryngeal nerve. But the movement may arise from stimuli applied to other branches of the vagus."

"In sneezing, the general movement is essentially the same (as in coughing), except that the opening from the pharynx into the mouth is closed by the contraction of the anterior pillars of the fauces, and the descent of the soft palate, so that the force of the blast is driven entirely through the nose. The afferent impulse is usually given from the nasal branches of the fifth." When sneezing, however, is produced by bright light, the optic nerve would seem to be the afferent nerve.

In Landois and Stirling, sneezing is described as consisting "of a sudden violent expiratory blast through the nose for the removal of mucus or foreign bodies (the mouth being rarely open), after a simple or repeated spasm-like inspiration (the glottis remaining open)."

In "McKendrick's Physiology," coughing and sneezing are described as powerful expirations, in which the air is driven through the oral cavity in the first, and through the nasal passages in the second.

"Hermann's Physiology" contains the following:—"The expulsion of foreign particles. Such explosive expiration is called sneezing when the nasal cavities are concerned, and coughing when the irritant is in the larynx."

Each is accompanied by a noise produced by the sudden bursting open of a closed aperture, which in sneezing is found by the opposition of the velum palati to the pharyngeal wall, and in coughing by the opposed vocal cords.

In "Carpenter's Physiology" it is stated "the difference between coughing and sneezing is this, that in the latter the communication between the larynx and the mouth is partly or entirely closed, by the drawing together of the sides of the velum palati over the back of the tongue, so that the blast of air is directed more or less completely through the nose in such a way as to carry off any source of irritation there. Of the purely automatic character of the movement of sneezing there can be no question, since it cannot be imitated voluntarily."

In "Kirk's Handbook of Physiology" we find "the same remarks that apply to coughing are exactly applicable to the act of sneezing, but in this instance the blast of air escaping from the lungs is directed by an instinctive contraction of the pillars of the fauces, and descent of the soft palate, chiefly through the nose, and any offending matter is expelled."

In "Huxley's Elementary Physiology" it is stated "in sneezing, the cavity of the mouth is described as being shut off from the pharynx by the approximation of the soft palate and the base of the tongue, the air being forced through the nasal passages."

All these writers, then, are agreed in describing sneezing as a modified respiratory act, in which air is blown through the nose, and most of them assume that it consequently serves the purpose of driving irritating substances from the nose.

On the other hand, in one of the most recent works on the diseases of the nose (Greville MacDonald, published 1892), one finds the following reference to sneezing:—"Again, it may be doubted whether the physiological reflexes can be considered in any way beneficial. Sneezing, it may be argued, is not of any use in driving irritating particles from the nose, seeing that it consists essentially in a closing of the palate during spasmodic expiration, and thus prevents the current of air from passing through the nose. But we probably find the most accurate explanation

of the phenomenon in the following considerations:—On the entrance of an irritating particle into the nose, the primary object of the reflex phenemonon is to increase the flow of mucus, not only for the sake of interposing some non-irritating substance between the sensitive membrane and the foreign particle, but even more for the purpose of washing it away. This increased flow is produced by a double mechanism. In the first place there is a supply of more blood, and the stimulation of the secreting cells, through nerve influence; and in the second, there is an increase of vascular pressure from over-filling of the venous sinuses, as described in Chapter I. Now, this pressure on the venous sinuses must be enormously increased by the convulsive respiratory act comprised in sneezing. This latter consists in a violent contraction of the diaphragm, &c., together with the closing of the glottis and the post-nasal space, by contraction of the velum and the superior strictors and of the buccal orifice by the approximation of the tongue firmly to the teeth and hard palate; in fact, every possible movement is thrown into action to prevent the exit of air from the larynx, mouth, and nose. What is the immediate consequence of this? Increase of the intra-thoracic pressure, which necessarily increases the intra-vascular tension, especially in the veins, and hence in the venous sinuses of the nose. The act of forcible expiration, with all the outlets from the thorax closed, if voluntarily induced, *i.e.*, without the preliminary irritation in the nose, is scarcely operative in producing the effect described, and it is probably only when the nerve stimulation is excited at the same time, and the gland cells are set working, that this increase in the venous pressure is of some additional assistance."

Reviewing these conflicting statements, we find difference in matters of fact, and necessarily in the inferences drawn from them. Of the inaccuracy of the description of sneezing given in "Foster's Physiology" and the other works referred to, there can be no question. The process seems to be similar to that followed in coughing, with the following amongst other distinctions:—(1) That it is entirely involuntarily. (2) That it is caused mainly through stimulation of the anterior portion of the nose. Stimulation of the posterior portion of the nose generally results in coughing. (3) That the forced expiration is, if anything, more marked than in coughing. (4) That the air in persons with normal palate (and apart from voluntary efforts modifying the act) is

driven entirely through the mouth; that is to say, that the palate is probably pressed firmly back against the pharynx so as to completely cut off communication with the nose. The peculiar noise made in sneezing is probably produced by the impact of the imprisoned air on the back of the hard palate, combined with certain modification of the shape of the mouth produced by movements of the tongue and lips. In coughing, on the other hand, it would seem that the communication between the nose and throat is not necessarily cut off, and that the air sometimes passes through the nose as well as the mouth, and that special movements of the lips and tongue are certainly different, if not absent altogether. The mouth is generally opened more widely in coughing, and the noise produced by a cough is very different from that produced in sneezing. The one is laryngeal in the main, the other is chiefly buccal.

It is possible that the glottis has nothing to do with sneezing, and that the obstruction is entirely pharyngeal. If, however, there is a closed glottis, it is probable that the mode in which it is opened in the two cases is somewhat different. Coughing has, at all events, sometimes a definite object to serve. It serves for the removal of irritating particles from the air passages, and it is quite likely that the glottis may be differently disposed in sneezing. Hence the absence of glottic noise in sneezing. The statement that the blast of air in sneezing is driven through the nose has originated, I think, in the following manner:—The observations have been necessarily almost entirely personal, and as usual the introspective method, if the term can be used in this sense, has again proved fallacious. When people sneeze, they feel first a profound irritation in the anterior part of the nose. If this persists, there follow some long and deep inspirations, then a violent expiratory effort with possible closure of the glottis or some part of the pharynx; the obstruction is suddenly overcome, and the air expelled through the mouth with the characteristic noise. Usually there follows almost immediately a gush of watery fluid from the nose, which is evidence of increased secretion.

Now, putting these facts together, those who first described the process of sneezing, confused as usual inference and fact. They knew that coughing, at all events, served the one purpose of removing foreign bodies from the air passages. They inferred justly or unjustly that sneezing was adapted to remove foreign bodies from the anterior portion of the

nose by means of the blast of air. They felt the irritation of the nose, and found that sneezing was usually followed by relief. Without examining carefully the act of sneezing, to see whether the air did or did not go through the nose, they assumed that it did, hence the description. It is of course possible that, in some cases where observation was made, abnormal conditions of the palate may have permitted portions of the air to get to the nose. As the act of sneezing is involuntary, while that of coughing is not, it is impossible to study the phenomena of the former, except in an impromptu and largely subjective manner. The vocal cords can be examined with the laryngoscope in coughing, but not in sneezing. Objective examination in sneezing is very limited, by reason of the nature of the act. It seems to me, however, perfectly clear that we have another example of the manner in which hypothesis has biassed observers. They have unconsciously endeavoured to make the facts fit the theory. An observation once made and stated by a competent authority has probably been copied from one work into another, until of late years the great importance given to physiological respiratory reflexes by physicians has caused the matter to be more closely investigated.

Greville MacDonald's ingenious theory of the value of sneezing, physiologically, may or may not be accurate. The fact, however, that patients suffering from eye disease frequently sneeze when exposed to a strong light, indicates the necessity for caution before assuming that sneezing has any value whatever. It may have as little to do with normal physiological function in the human being as apparently has the patellar reflex, the cremasteric reflex, or some other of the general reflexes. If sneezing is essential to the removal of a foreign body from the anterior portion of the nose, it is very difficult to understand why coughing or blowing through the nose would not be equally serviceable. As Greville MacDonald justly observes, "it is quite certain that sneezing alone cannot produce the rush of fluid from the nose. It requires a local determining agent. At present, it seems to me the only conclusion that can be safely arrived at, is the Agnostic one." Greville MacDonald's explanation is plausible, and has the merit, as far as I know, of standing alone.

How much more fallacious observation of a similar character exists in all departments of science, it is impossible to conjecture, but I think it fairly certain that, if the

treatment of diseases of the nose had not become organised into a special department of medicine, it would have been assumed that the significance of the respiratory reflex was fully understood. My object in drawing attention to the matter is—(1) To put the facts, as far as possible, before members. (2) To stimulate observation, which from the necessity of the case must be largely personal. (3) To give another example of the manner in which good observers are biassed by the teleological assumption. (4) Of the manner in which such fallacious observations lead men to accept explanations which wrongly colour the work of those who have to apply them in practical life. An accurate statement of facts with regard to sneezing, would probably have stimulated inquiry into the relation between nasal disease and asthma, at a much earlier date than 1871, when attention was first drawn to the matter by Voltolini.

Art. XVI.—*Physical Constants of Thallium.*

(With Plate XVII.)

By W. Huey Steele, M.A.

[Read November 10, 1892.]

Being in possession of a piece of thallium, and being unable to find its constants in the ordinary books of reference, I determined a few of them as follows. The investigation was conducted in the Physical Laboratory of the University of Melbourne.

(1) Coefficient of Expansion.

A piece of the thallium was drawn into a wire about fourteen inches long, the ends cut off square, and a nick made near each end. It was put into a glass tube through which steam could be passed at will from a small boiler. The ends of the tube being firmly clamped, micrometer microscopes were focussed on the ends of the wire. These instruments, supplied by the Cambridge Scientific Instrument Co., read to $\frac{1}{10000}$ inch. The positions of the ends of the wire and of the outer and inner edges of each nick were observed, the observations being repeated several times. The temperature of the thallium was assumed to be that indicated by a thermometer left lying beside the glass tube all night, 16·8° C. Steam was then passed along the tube till it was fairly dry, and after about fifteen minutes, the observations of the positions of the nicks and ends of the wire were repeated, the temperature being assumed to be 100° C. The gain in length of the whole wire was observed to be ·0261 inch, between the outer edges of the nicks ·0255 inch, and between inner edges ·0255 inch. On replacing the glass tube by a scale, the length of the wire was found to be 13·83 inch, and the distance between the nicks 13·69 inch. Dividing the increase in length by the rise in temperature (83·2°), and by the length measured, the coefficients come out ·0000227, ·0000224, ·0000224, giving as mean result ·0000225.

(2) Specific Resistance.

I at first made several determinations of the resistance of the thallium, in the form of short thick wires, and compared its resistance with silver, and afterwards with lead, and separately determined the resistances of the specimens used in comparison. I found it much more accurate however to draw the thallium into a finer wire, and determine its resistance directly. This was done with a resistance box, with a shunt on the variable arm. It was measured several times at slightly different temperatures, as shown in the following table:—

t	r	s	R^1	R
21	·16	5·80	·1557	·1551
21·8	·16	6·55	·1562	·1551
22·1	·16	6·87	·1564	·1551
22·1	·17	1·95	·1564	·1551

t is the temperature centigrade, r and s are the two resistances in parallel which balance the resistance of the thallium. R^1 is $\frac{rs}{r+s}$, the observed resistance of the thallium, and R is the resistance at 20° C., reduced by the coefficient ·0039 (*vid. inf.*) The length of the thallium was 46·14 cm., and the mean value of diameter measured at different parts along it was ·0874 cm., the mean error in measuring it being ·0005 cm. The specific resistance at 20° C. is therefore

$$\frac{\pi \times \cdot 0437^2 \times \cdot 1551 \times 10^9}{46 \cdot 14} = 20170.$$

(3) Variation of Resistance with Temperature.

To determine this, the thallium was made into a small coil, and immersed in a large beaker of water, with a thermometer about the middle of the coil. The thallium was connected with the terminals of a slide metre bridge by means of two stout pieces of copper, to which it was firmly bound, and whose resistance was found to be about $\frac{1}{100}$ of that of the thallium. The resistance of the thallium was balanced with an approximately equal resistance of German silver, which was taken as an arbitrary unit to measure the resistance of the thallium at different temperatures. By means of a very sensitive galvanometer, the slider could be adjusted to ·1 mm., while the whole change in position for a rise of 80° C. was about 70 mm. In reducing the bridge

readings to resistances, correction was made for the fact that the middle point of the wire was not the electrical centre, which was 3·3 mm. to one side, and the resistances were diminished by 1 per cent. of the cold resistance of the thallium on account of the copper connections. Two independent sets of observations were made, and from each the coefficient at 20° C. was calculated by the method of least squares. The figures from which the calculations were made are given in the annexed table :—

Set 1.		Set 2.	
t	R	t	R
17·8	·987	16·2	1·017
30·5	1·035	32·1	1·079
41·4	1·074	48·2	1·143
51·7	1·102	61·4	1·196
62·1	1·154	79·8	1·274
80·3	1·227	99	1·357
98·8	1·312	85·1	1·298
		72·2	1·246
		67·5	1·226

The values of the coefficient from the above tables are ·00394 and ·00400.

Having determined these values by means of the slide bridge, I proceeded to verify the result by measuring the resistances with a resistance box, and shunt as described above. Two independent sets of observations were made as before. The observed values are given in the following table :—

Set 3.		Set 4.	
t	R	t	R
18·1	·2054	17·3	·2134
32	·2162	59·3	·2490
40·6	·2228	80·9	·2679
53	·2329	99·3	·2812
60·7	·2381	54	·2456
72·1	·2488	24·9	·2232

The values of the coefficients from sets 3 and 4 are ·00384 and ·00391. The mean of these four gives, as the coefficient at 20° C., ·00392. This is larger than the value for most metals other than iron.

(4) Thermo Electric Height.

As I had a piece of pure silver, and no other metal pure, I resolved to find the thermo electric height of thallium with regard to silver, and assume Professor Tait's result for silver in order to obtain the absolute value for thallium. Having done so, it was found that the thallium line thus determined, crossed Professor Tait's copper line at about 70° C., and that copper was therefore an exceptionally favourable metal with which to compare thallium. I therefore obtained pure copper and compared thallium with it, and found that thallium was further below copper than below silver; and on finally trying copper and silver, I found the lines should be very much closer together than they are in Professor Tait's diagram, and that copper should be above silver and not below it. I therefore purified some lead, and constructed a diagram of my own for the four metals—lead, thallium, copper and silver. To obtain pure lead, I dissolved some sheet lead in nitric acid, and precipitated it as sulphate by adding dilute sulphuric acid. The sulphate thus obtained was heated with carbonate of soda and cream of tartar in a Hessian crucible in an injector furnace, and lead obtained which was assumed pure, though it contained a trace of potassium. I used an astatic low resistance galvanometer with a lamp and scale, at a distance of about four feet, the scale divisions being fortieths of an inch. The resistance of the galvanometer was somewhat less than an ohm, but with the leads and the wires of the thermo electric circuit, the resistance was a little over an ohm. So low an E.M.F. as ·000001 volt or 100 absolute units gave a deflection of one scale division. This appears to be about 30 times as sensitive as the one used by Professor Tait twenty years ago. To determine the exact value of a scale division, the galvanometer was joined in series with an ordinary Daniell cell and various high resistances, and immediately after or before its E.M.F. compared with a Latimer Clark cell, by means of a condenser and balliatic galvanometer. In

examining the thermo electric power of two metals, I twisted together their ends and coiled the joint round the bulb of a thermometer, immersing the whole in a bath of olive oil. The other junction was kept in a large beaker of cold water with a thermometer in it, which was observed from time to time, and if necessary, correction made for the rise of temperature. This rise was never more than a degree, the corresponding correction being one or two scale divisions. The relation between the observed values of temperature and galvanometer reading is parabolic, and if we express the excess of the temperature of the hot junction over the cold by t, and the number of scale divisions by s, then $s = a\ t + b\ t^2$ is the connection between s and t, where a and b are constants to be determined preferably by the method of least squares, as was done with each set of observations, though the operation is rather laborious. The following table may be taken as typical of the accuracy attained :—

T	s (*observed*)	s (*calculated*)
19	0	0
76	114	119
73	107	112
70	102	108
76	115	119
131·7	206	201
130	202	199
180·3	249	249
200	259	260
184	249	250
179	246	247
161	232	232

In this case, the metals being thallium and lead, the resistance of the circuit was 1·395 ohm. The equation to the parabola, represented by the first and second columns, is $s = 2{\cdot}36\,t - {\cdot}00512\,t^2$ where $t = T - 19$. A Daniell cell, when used to charge a condenser, gave a throw of 276·3 sc. divs.; a Latimer Clark cell gave 346·4; the E.M.F. of the Daniell is thus—$1{\cdot}435 \times 276{\cdot}3 \div 346{\cdot}4 = 1{\cdot}144$.

The same Daniell, when connected in series with the galvanometer, gave a deflection g for resistance R. If the

g	R
142·5	12000
176	10000
195	9000
246	7000
287	6000
213	8000

current through the galvanometer be $k\,g$, then $\frac{1 \cdot 144}{R} = k\,g$, or $k = \frac{1 \cdot 144}{R\,g}$. Now the mean value of $R\,g$ is 1729000, therefore $k = \frac{1 \cdot 144}{1729000}$. If e be the electromotive force of the thermal circuit, and r its resistance, then $e = k\,s\,r$, or the electromotive force corresponding to one scale division is $\frac{1 \cdot 144 \times 1 \cdot 395}{1729000}$ volt, or 92·3 absolute units of electromotive force.

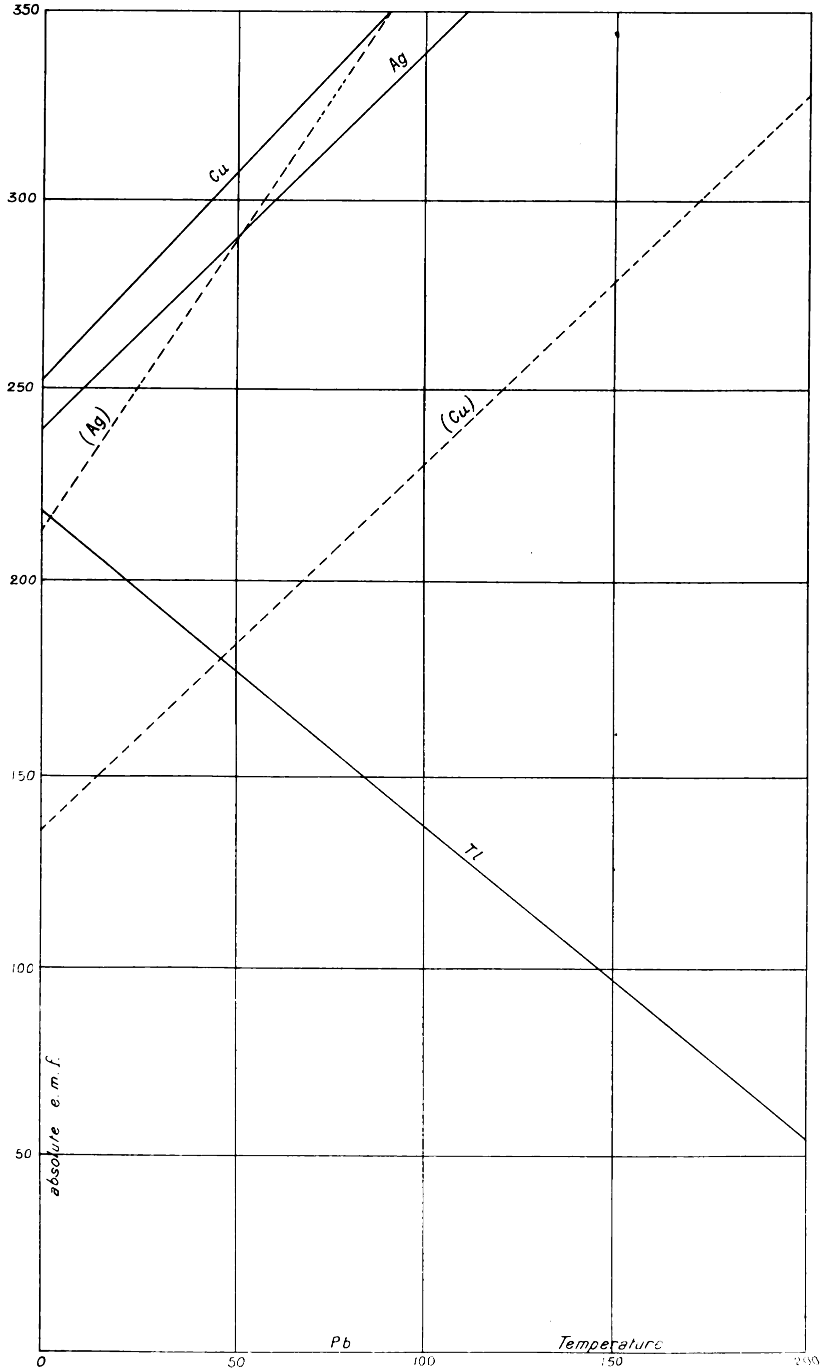
Now $s = 2 \cdot 36t - \cdot 00512t^2$, or if we measure the temperature from the neutral point of the two metals, $s = \cdot 00512t^2$. If the temperatures be the neutral point, and 100° above or below it, and if m be the relative Thomson effect, then $51 \cdot 2 \times 92 \cdot 3 = 5000\,m$, and $m = \cdot 94$.

To find the neutral point—$\frac{d\,s}{d\,t} = 0$, *i.e.*, $2 \cdot 36 - 2 \times \cdot 00512\,t = 0$, $t = 230$, *i.e.*, 249° C.; the height at 0° C. is therefore $249 \times \cdot 94 = 234$. The thermo electric height of thallium above lead is thus—$234 - \cdot 94\,t$, t here being temperature centigrade.

Another similar but independent set of observations gave as the height $198 - \cdot 65\,t$, the mean of these being $217 - \cdot 79\,t$. Of the four metals, each pair was taken together, and the following results obtained. In each case the higher metal is the first :—

1.	Thallium–Lead - -	$217 - \cdot 79\,t$
2.	Copper–Thallium -	$43 + 1 \cdot 79\,t$
3.	Copper–Lead - -	$252 + 1 \cdot 06\,t$
4.	Copper–Silver - -	$12 + \cdot 10\,t$
5.	Silver–Thallium - -	$40 + 1 \cdot 47\,t$
6.	Silver–Lead - -	$206 + 1 \cdot 35\,t$

If we add the Thallium–Lead to the Copper–Thallium, we get $260 + 1 \cdot 00\,t$, which agrees fairly well with the directly


350
300
250
200
150
100
50
Cu
Ag
(Ag)
(Cu)
Tl
absolute e. m. f.
Pb
Temperature
0
50
100
150
200

observed value of Copper-Lead. The results with the silver are not very consistent. Various diagrams can be constructed from the above observations, but the nearest to the true one will probably be obtained from the first, third and fourth, from which the figure is drawn (see Plate XVII), the dotted lines on the figure being Professor Tait's results for silver and copper.

I have been for some months engaged on a series of observations, of which I hope to give an account to this Society shortly, from which it appears that thermo electric values cannot be absolutely constant, and which explains the above inconsistent results of the observations on these metals.

SUMMARY.

The constants obtained are thus :—

(1)	Coefficient of expansion -	·0000225
(2)	Specific resistance - -	20200 at 20° C.
(3)	Range of resistance with temperature - -	·00392 at 20° C.
(4)	Thermo electric height -	216 — ·79 t

The thallium was obtained from Schuchardt, and Professor Masson has kindly analysed it and supplied the following statement of his results :—

"The small sample of thallium wire submitted to me, was found to contain as impurities, lead, arsenic and copper. An estimation of the lead showed it to be present to the extent of 1·50 per cent. The arsenic and copper were present in too small amount to be estimated in so small a sample. A direct estimation of the thallium itself showed the wire to contain 97·90 per cent. of that metal."

ART. XVII. — *On "Confocal Quadrics of Moments of Inertia" pertaining to all Planes in Space, and Loci and Envelopes of Straight Lines whose "Moments of Inertia" are Constant.*

By MARTIN GARDINER, C.E.

[Read May 12, 1892.]

ABSTRACT.

The author commences by solving the following problem, by the Cartesian co-ordinate method :—

Problem.—Given any number of points $P_1, P_2, P_3, \ldots$ in space, and corresponding numbers $a_1, a_2, a_3, \ldots$, known in signs and magnitudes as respective multipliers; to find the Envelope of a plane $L\,L\,L$, such that, in every position it can assume, we shall have

$$a_1 \cdot p_1^2 + a_2 \cdot p_2^2 + a_3 \cdot p_3^2 + \ldots = S,$$

in which $p_1^2, p_2^2, p_3^2, \ldots$, represent the squares of the pedals from the points $P_1, P_2, P_3, \ldots$, to the plane $L\,L\,L$; and S a constant entity known in sign and magnitude.

He finds the ~~equation~~ of the envelope of the plane $L\,L\,L$ to be that of a Quadric whose centre is coincident with the mean-centre of the given points for the multipliers $a_1, a_2, a_3, \ldots$ And from the *form* of the equation arrived at (which is given abridged and expanded), he infers that for all possible values of the entity S, the corresponding Quadrics are Confocal Quadrics.

He then shows by a purely geometrical method (independent of co-ordinates) that for any constant value of S, the

envelope of the plane $L L L$ is a Quadric whose centre is coincident with the mean centre of the points P_1, P_2, P_3, . . . , and their respective multipliers a_1, a_2, a_3, ... And he shows that the quadrics corresponding to all possible values of the entity S, are Confocal Quadrics.

In order to amplify his Geometrical Method, he proceeds to give a full and complete solution to the particular cases in which the given points P_1, P_2, P_3, . . . , are all in one straight line. And he shows that it depends on the state of the data, as to whether the Confocal Quadrics be Ellipsoids; Hyperboloids of One Sheet; Hyperboloids of Two Sheets; Spheres; or Paraboloids.

He then directs attention to the Physical Aspect of the problem, which he enunciates as follows:—

Problem.—Given any masses M_1, M_2, M_3, . . . , in space, and corresponding units a_1, a_2, a_3, . . . , known in signs as their respective multipliers; to find the Envelope of a plane $L L L$, such that in every position it can assume, we shall have the sum of the Moments of Inertia of the masses represented by

$$a_1 . \lesseqgtr m_1 (P_1 L)^2 + a_2 . \lesseqgtr m_2 (P_2 L)^2 + a_3 . \lesseqgtr m_3 . (P_3 L)^2 + \ldots = a \text{ constant } S,$$

in which m_1, m_2, m_3, . . . represent molecules of the masses M_1, M_2, M_3, . . . , at any points P_1, P_2, P_3, . . . in those masses, and in which $P_1 L$, $P_2 L$, $P_3 L$, . . . represent the pedals from the points P_1, P_2, P_3, . . . , to the plane $L L L$.

In elucidation of this aspect of the problem, he reconsiders the particular cases, in which he now replaces the given points or molecules at P_1, P_2, P_3, . . . all in one line, by Spheres whose centres are all in one straight line. He shows that the results arrived at previously, apply when masses replace mere molecules; and that, according to analogous states of the data, the Confocal Quadrics will be Ellipsoids, Hyperboloids, Spheres, or Paraboloids.

He establishes the limiting values for the constant S, and exposes the limiting forms of the Quadrics in minute and full detail. And he corroborates a remarkable theorem of

Duhamel's, as to the existence of two points, *for each of which* Poinsot's "Ellipsoid of stress" is a Sphere. He shows, moreover, these two points to belong to a "Focal Conic" of the family of Confocal Quadrics.

In the case in which the bodies are Spheres *situated in any manner in space*, he gives a simple and effective method of finding the three principal axes of inertia.

He then records the following eight Theorems, as results of his investigations:—

THEOREM 1.

Given any masses M_1, M_2, M_3, . . . in space, and corresponding numbers a_1, a_2, a_3, . . . of known signs as multipliers. If a plane $L\,L\,L$ (otherwise unrestricted) be such that in every position it can assume, the sum of the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, $a_3 . M_3$, . . . , with respect to it, be of any constant magnitude S, then will the envelope of the plane be a determinable quadric Q, whose centre is coincident with the mean centre of the entities. And the whole system of quadrics Q_1, Q_2, Q_3, ... corresponding to all values S_1, S_2, S_3, ... , of S, will be concentric, coaxial, and confocal quadrics. And in all cases in which the multipliers a_1, a_2, . . . are all positive, the quadrics will be Ellipsoids and Hyperboloids of One Sheet.

THEOREM 2.

Given any masses M_1, M_2, M_3, . . . in space, and corresponding numbers a_1, a_2, a_3, . . . of known signs, as multipliers. The *envelope* of all planes $L\,L\,L$ passing through any given point V in space, and such that the sum of the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, $a_3 . M_3$, ... , with respect to them severally, is of any constant magnitude S, will be a determinable quadric cone C, which envelopes a determinable quadric Q whose centre is coincident with the mean centre O of the entities. And the whole family of such cones C_1, C_2, C_3, . . . , corresponding to all values S_1, S_2, S_3, . . . , of S, will be coaxial and confocal cones enveloping coaxial and confocal quadrics, whose common centre is the mean centre O of the entities

$a_1. M_1, a_2. M_2, \ldots\ldots$ And if the point V be at infinity, and given in direction by means of a vector $O\,R$ passing through the mean centre O; then, corresponding to various values of S, the envelopes of $L\,L\,L$ consist of a system of confocal cylinders enveloping the quadrics, and having as common principal axis the directing vector $O\,R$.

Now M_1, M_2, M_3, . . . being masses, and a_1, a_2, a_3, numbers known in signs: we know that if a plane $L\,L\,L$ be such that the sum of the moments of inertia of the entities $a_1. M_1$, $a_2. M_2$, $a_3. M_3$, . . . , with respect to it is of a constant magnitude S, then will the envelope of the plane be a determinable quadric Q. But the line of intersection $l\,l$ of any two mutually orthogonal planes, both tangent to the quadric Q, is obviously such that the sum of the moments of inertia of the entities with respect to it is represented by $2.s$.

We can easily form the equations of tangent planes to the quadric Q, and express their mutual orthogonism; but we need not try to evolve an equation of *a surface* which could be the envelope of all the lines $l\,l$ of intersection of the pairs of mutually orthogonal tangent planes to Q. This is obvious:—for if we suppose p to be any point whatever on any surface, and construct a Poinsot Ellipsoid having such point as centre, we perceive that the lines $l\,l$ through the point form a cone, and cannot generally *all* be tangents at one point to any other surface. However, we proceed to find the Loci and Envelopes of lines $l_1\,l_1$ which fulfil the conditions as to equality of moments of inertia, and respecting which other conditions are imposed.

1°.—With respect to all the lines $l_1\,l_1$ which are parallel to any fixed straight line $R\,R$ passing through the mean centre O, which is also the centre of the quadric Q_1.

If through O we draw a plane normal to the line $R\,R$, and that we put $c_1\,c_1\,c_1$ to represent the conic which constitutes its trace on the quadric Q_1: then, from a well-known theorem, we perceive that the pairs of mutually orthogonal tangent planes whose points of contact lie in the conic $c_1\,c_1\,c_1$, give us all the lines $l_1\,l_1$ parallel to the fixed line $R\,R$, and that they constitute a Right Circular Cylinder having $R\,R$ as central axis.

2°.—With respect to all the lines $l_1 l_1$ situated in tangent planes to the quadric Q_1.

We may first observe that if $P_1 P_1 P_1$ be any fixed plane tangent to the quadric Q_1, and that we project the quadric itself orthogonally by means of other tangent planes upon $P_1 P_1 P_1$, then will the projection be a conic $c_1 c_1 c_1$ situated in the plane $P_1 P_1 P_1$, which is obviously the envelope of all the lines $l_1 l_1$ in the plane.

3°.—With respect to all the lines $l_1 l_1$ situated in any plane BBB whatever.

We first proceed and find the sum s_q of the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, $a_3 . M_3$, . . . , with respect to the plane BBB. We then find the quadric Q_o such that the sum of the moments of inertia of the entities with respect to any of its tangent planes is $= 2.s_1, —s_q$. Then, obviously, the orthogonal projection of the quadric Q_o so found (by means of tangent planes to it) upon the plane BBB will be a conic, which is the envelope of the lines $l_1 l_1$ situated in the plane.

The following is an obvious deduction :—

THEOREM 3.

Given any masses M_1, M_2, M_3, . . . in space, and corresponding numbers a_1, a_2, a_3, . . . of known signs as multipliers; and given also the system of confocal quadrics Q_1, Q_2, Q_3, . . . , such that the sum of the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, $a_3 . M_3$, . . . , with respect to tangent planes to the quadrics are equals respectively to s_1, s_2, s_3, . . . ; then the orthogonal projections of the quadrics on any given plane BBB in space, constitute a family of confocal conics, which are the respective envelopes of straight lines $l_1 l_1$, $l_2 l_2$, $l_3 l_3$, ... , situated in the plane, such that the sum of the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, $a_3 . M_3$, . . . , with respect to them, are determinable constants. And if the plane $B_1 B_1 B$ be parallel to either one of the two systems of parallel circular sections of the confocal quadrics, then will

the projections of the quadrics on the plane be a system of concentric circles.

NOTE.—The differences of the moments of inertia with respect to the lines $l_1 l_1$, $l_2 l_2$, $l_3 l_3$, . . . , (tangents to the respective conics) on the plane BBB are obviously equals to the differences of the moments of inertia with respect to tangent planes to the quadrics Q_1, Q_2, Q_3, . . .

If we draw planes $P_1 P_1 P_1$, $P_2 P_2 P_2$, . . . , through any diameter DD of any one Q of the family of Confocal quadrics. the lines ll situated in these planes and such that the sum of the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, $a_3 . M_3$, . . . , with respect to them, severally, is of any constant magnitude $2.s$, have (as already observed) as envelopes, in the planes, determinable conics. And we know that those of the lines ll which are parallel to DD form a circular cylinder, having the line DD as axis. But it is easy to perceive that it is only when the axis DD is normal to one of the circular sections of the quadric Q that the conics cut DD in the one and same point, at which the lines ll form a tangent plane to all the conics. Hence:—

THEOREM 4.

Given any number of masses M_1, M_2, M_3, . . . , in space, and corresponding numbers a_1, a_2, a_3, . . . , of known signs as multipliers; if a straight line ll move in space so as to be always in contact with the line DD of a diameter of any quadric Q (of the confocal family) normal to either system of its circular sections, and so that in every position the sum of the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, . . . , with respect to it, is of any constant magnitude $2.s$; then will the envelope of the straight line ll be a determinable quadric w of revolution, having the mean centre O as centre, and the fixed line DD as axis. And all such quadrics w_1, w_2, w_3, . . . , corresponding to all possible values $2.s_1$, $2.s_2$, $2.s_3$, . . . , of the constant are determinable quadrics of revolution, having the mean centre O as common centre, and the line DD as principal axis.

THEOREM 5.

The Locus of a straight line ll through any fixed point D^1 in a line DD through the mean centre O and normal to

circular sections of the confocal quadrics Q_1, Q_2, Q_3, . . . , and such that the sum of the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, . . . , with respect to it, is of constant magnitude $2.s$, is a quadric cone of revolution, having the point D^1 as vertex, and D D as axis.

We know that the *locus* of the lines l l of intersection of all pairs of mutually orthogonal tangent planes to any quadric, cone C is another quadric, cone E concyclic with the reciprocal of the cone C. (See Salmon's "Geometry of Three Dimensions," Art. 247). And if C be a cone, such that the sum of the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, . . . , with respect to its tangent planes, severally, be equal to a constant s, we know that the sum of the moments of inertia of the entities with respect to the lines l l, severally, must be equal to $2.s$. Hence we have:—

Theorem 6.

Given any masses M_1, M_2, M_3, . . . , in space and corresponding numbers a_1, a_2, a_3, . . . , of known signs, as multipliers; the Locus of a straight line l l passing through any given point V in space, and such that the sum of the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, $a_3 . M_3$, . . . , with respect to it = any constant $2.s$, is a quadric cone E, having the point V as vertex, and concyclic with the reciprocal of the cone C, having V as vertex, and such that the sum of the moments of inertia of the entities with respect to its tangent planes = s, &c.

Theorem 7.

If three planes, always mutually orthogonal, move in space so as to continue to be tangent planes respectively to any three of the confocal quadrics Q_1, Q_2, Q_3; then will the Locus of their common point of intersection be a *Sphere*, whose centre is coincident with the mean centre O of the entities $a_1 . M_1$, $a_2 . M_2$, . . . , which is also the centre of the quadrics.

Note.—This Theorem, which is an obvious deduction from the kinetic properties exposed, was arrived at by Salmon by means of a formula due to Chasles. (See Salmon's "Geometry of Three Dimensions," Art. 172.)

THEOREM 8.

If two planes A and B mutually orthogonal, be tangent planes respectively to any two quadrics Q_1, Q_2, of the confocal family; then will the other pair of tangent planes A^1 and B^1 through their line of intersection $l\,l$, to the same two quadrics, be mutually orthogonal.

This is an obvious deduction from the kinetic properties exposed.—The planes A and B being tangents to the quadrics Q_1 and Q_2, the moments of inertia of the entities $a_1 . M_1$, $a_2 . M_2$, . . . , with respect to them are constants s_1 and s_2; and the sum $s_1 + s_2$ of these moments of inertia is equal to the moment of inertia of the entities with respect to their line of intersection $l\,l$. And since the moment of inertia with respect to the line $l\,l$ is equal to the sum of the moments of inertia with respect to the tangent planes A^1 and B^2, it follows that A^1 and B^1 must be mutually orthogonal.

This theorem is an extension to confocal quadrics of one pertaining to confocal conics, due to Admiral De Jonquières of the French Navy, who is one of the most distinguished geometers in Europe. (See "Mélanges de Géométrie Pure," par E. De Jonquières.)

OBSERVATIONS.

The family of confocal quadrics Q_1, Q_2, Q_3, . . . , and the properties of inertia pertaining to them, are worthy of attention, not only on account of their intimate connection with "Wave Surfaces," and "Surfaces of Elasticity," but also on account of their direct applications to many important problems. (See Salmon's "Geometry of Three Dimensions," Arts. 467, 480, &c.)

2°.—Some interesting properties pertaining to confocal quadrics can be deduced by application of the numerous new theorems arrived at by the author, and published in Vol. X of the "Quarterly Journal of Pure and Applied Mathematics," under the title—"Properties of Quadrics having Common Intersection, and of Quadrics inscribed in the same Developable."

3°.—Since writing the present paper, the author has found that the question had been previously considered by the late Professor Townsend, of the Dublin University.

The results at which he arrived are given *without any investigations* on page 312 of Williamson's "Integral Calculus." From question 19, as there enunciated, it would appear that Townsend did not perceive that the envelope of the plane is an ellipsoid only when the prescribed moment of inertia is not less than a certain determinable magnitude; or that it is a Hyperboloid of One Sheet for all values less than such limiting value. Nor does it appear that he considered the case in which the envelope of the plane is a Hyperboloid of Two Sheets, or any limiting values of the moment of inertia.

Art. XVIII.—*Notes on a Poisonous Species of Homeria (H. collina, Vent.—var. miniata), found at Pascoe Vale, causing death in cattle and other animals feeding upon it.*

By D. McAlpine and P. W. Farmer, M.B., Ch. B.

[Read November 4, 1892.]

Introductory.

The sudden death of a number of cattle at Pascoe Vale, a suburb of Melbourne, about the middle of September, attracted a good deal of attention, and from various accompanying circumstances, there were grounds for believing that the herbage had something to do with it. Specimens of the supposed poisonous weed were sent to Baron von Mueller, Government Botanist, and he determined it to be a species of *Homeria*, a native of South Africa. He remarked that "in their native country occasionally pasture animals have suffered from these kinds of plants, but no poison cases have hitherto come under my own notice."

Veterinary surgeons also took the matter up, and they decided the deaths to be due to anthrax, the sudden illness of the animals and the subsequent deaths of many of them giving colour to this supposition; but it does not appear that the anthrax bacillus (*Bacillus anthracis*, Cohn) was found in the spleen of the dead animals, which is always considerably swollen and full of enormous quantities of these bacilli, when death is due to that cause. But skilled veterinary surgeons may be wrong, and the plain, common sense farmer may be right in some instances, even where the death of cattle is concerned, and here was evidently a case where further investigation was desirable. Since the *Homeria* plant, which was known to be eaten by the cows which died, was growing luxuriantly in patches extending

over several acres where the cattle was feeding, and since it belonged to a genus of plants well known to have poisonous properties, it became a matter of great importance to determine whether this particular plant was poisonous or not when grown in this Colony, so we decided to submit it to the test of experiment.

History of Outbreak of Disease.

A local dairyman brought ninety-five head of cattle from paddocks a short distance to the north of Pascoe Vale, and put them on the land overgrown with *Homeria*. Next morning, about twelve head were found either sick or dying. Another dairyman brought four head from Caulfield, putting them on the same land, and next morning two were dead and two sick. Several others lost cattle in the same paddock, and it is reported that more than twenty have died altogether. It is worthy of note that the cattle reared in the locality have escaped, and are in excellent health, while only those fresh to the district have succumbed. The plant has now died down, and no more sickness is reported, but in the season, when the fresh, green, tall leaves of the *Homeria* were fully developed, it looked quite a tempting green food. The owner of one of the cows which was treated and recovered assured us that it would not now eat the plant, although it had eaten freely of it before.

As regards the presence of the *Homeria* in the locality, it may have been originally a garden escape, since these flowers are cultivated for their beauty, but although several gardens in the neighbourhood were visited, no trace of it could be found. It has also been suggested that the plant may have been introduced along with the oats formerly sown in the paddock, for it may be multiplied by means of small bulbils which it produces in great abundance, and which might easily get mixed up with other seed.

References to Homeria being Poisonous.

As to the poisonous nature of this genus of plants, there are references in various standard works, such as Le Maout and Decaisne's "System of Botany," and Redwood's "Supplement to the Pharmacopœia;" but we shall content ourselves

with quoting from such a well-known work as Bentley's "Manual of Botany," 5th Ed., 1887. At page 703, he says:—"Moraea (Homeria). Some species of this genus, more especially that of *M. collina*, and of other iridaceous plants known under the name of "Tulp" at the Cape, have poisonous properties, and have been the cause of fatal results to cattle which have chanced to eat it. "Tulp" is also poisonous to human beings." Redwood refers to *Homeria collina* as Cape Tulip, and as a plant well known to almost every child in the Colony (Cape of Good Hope).

Reasons for Investigation.

Apart altogether from the practical importance of the subject, there were two main reasons which induced us to enter upon the investigation.

First, the poisonous plants introduced into Victoria have not yet been carefully recorded, and therefore any one to which suspicion attached was worthy of being enquired into, and its poisonous properties, if present, determined. In Queensland, a work has been prepared by F. M. Bailey, F.L.S., Colonial Botanist, and P. R. Gordon, Chief Inspector of Stock, entitled "Plants Reputed Poisonous and Injurious to Stock," but there is no mention in it of this one, nor even of the natural order to which it belongs. Also in New South Wales, the Botanist to the Department of Agriculture, Mr. Turner, has a paper on "The Supposed Poisonous Plants of New South Wales (both Indigenous and Exotic)," in *Ag. Gaz.* Vol. II, Part 3, 1891, but there is no reference to this plant or its order. Hence, a possible new poison plant, as far as these Colonies are concerned, deserved to be satisfactorily determined, in order to prevent its further distribution. Such a determination is a necessary preliminary step to its eradication, just as in Western Australia, where certain poisoned land, as it is called, can only be obtained on conditions of exterminating the poison plant, which is only dangerous at certain seasons of the year.

Second, as the cows which died at Pascoe Vale were said by skilled veterinary surgeons to have died from anthrax, and not from any supposed poisonous weed, this became a strong additional reason for sifting the matter to the bottom, and seeing if, after all, the reputed poisonous weed was simply an imagination of the cattle owners.

What is a Poison Plant?

A poison plant being one that poisons, the first thing to do was to settle that point, and then have the plant analysed, in order to determine the poisonous principle or alkaloid. Mr. P. Wilkinson, of the Government Analyst's Department, has made an extract from the plant. but found no alkaloid present. It is attempted to settle the former point in this paper, and in order to be clear as to what constitutes a poison, we shall take the definition as given in Guy and Ferrier's "Forensic Medicine," 6th Ed., 1888:—"A poison is any substance or matter (solid, liquid, or gaseous) which, when applied to the body outwardly or in any way introduced into it, can destroy life by its own inherent qualities without acting mechanically." And Dr. Neild's definition is:—"A poison is a substance which, taken into the body, is fitted to injure health." So if this plant can be proved to cause the death of animals feeding upon it, it will deserve the name of a poison plant, irrespective of the symptoms which it produces.

Experiments on Rabbits.

Knowing from the experiments of Professor Halford and others, that such drugs as opium and belladonna can be given in very large doses to dogs with comparatively little effect, the first difficulty was to decide upon and obtain suitable animals for experiment. After due consideration, we resolved to try the effects of the herb upon herbivorous animals such as rabbits, which Mr. Wyatt, of Woodlands Station, very kindly procured and sent to us. Three rabbits arrived on Saturday, 1st October, and were kept for a week on ordinary diet. They were all in good health and lively.

On Saturday, 8th October, at 4 p.m., two were placed in a separate cage and fed upon the *Homeria* plant, the other being reserved for future experiment. Fresh plants were brought from Pascoe Vale, and the portion growing above ground, similar to that eaten by the cattle, was moistened and given to the two rabbits. Nothing else was in the cage, and we saw them eat freely of the plant.

On Monday morning, 10th October, both were dead, and not expecting such a sudden effect, we did not watch symptoms very closely. However, the question of symptoms was a secondary one at this stage, the primary object being

to determine whether feeding upon this plant would cause death. On making the post-mortem, we found the mucous membrane of the stomach and intestines congested. The rabbit kept for control was lively and well as usual.

On Saturday, 15th October, the third rabbit which had been fed during the week on green food and was quite lively, was placed upon the same diet. About 6 p.m. it was given the freshly cut *Homeria* plant, which it readily ate. On Sunday morning it was drowsy, eyes half-closed and distinctly ill. Towards evening, there were distinct traces of scouring in the cage. At 11 p.m. it was still alive, but on Monday morning, 17th October, it died at 7 o'clock.

Post-mortem.—Externally marked evidence of scouring action on tail, &c. The liver congested, kidneys slightly congested. Bladder full, which was also observed in the other two rabbits. Before opening the stomach, little spots like ulcers could be seen in the wall, and on opening it was found to contain a quantity of the herb and some mucus. The contents were moister than in the other two rabbits, and marked corrosion was visible. The mucous membrane was completely charred in places, similar in fact to what would have been expected if strong sulphuric acid had been administered. When these black spots were removed, round patches of inflammation were visible, and on holding the stomach up to the light, these patches were very conspicuous, looking like little ulcers. The entire intestinal tract was congested.

Several more rabbits were obtained from the same quarter, and on Thursday, 20th October, two were again selected for feeding on the *Homeria* plant. This was given to them about 5 p.m., along with water, and next morning, 21st October, one had died. On examination, the stomach was full and congested. The second rabbit was found dead on Saturday morning, 22nd October, and the appearance of the stomach was similar to the first, only the peeling off of the mucous membrane was more marked. More of the plant had been eaten in the latter case.

In these experiments five healthy and lively rabbits were taken, and so sure as they were fed upon the *Homeria* plant, so surely did they die, within two days at the most, while other rabbits similarly kept, but fed on ordinary food, remained alive, and as fresh as when first received. Precautions were taken to exclude all disturbing elements, so

that the one point of difference was, that one set of rabbits were fed in the usual way and lived, while another set were fed on the *Homeria* plant and died.

It seems, therefore, reasonable to conclude that the eating of this plant was the cause of death, and that it is possessed of poisonous properties of an irritant nature.

Experiments on Cows.

It was considered quite satisfactory to test the effects of eating the *Homeria* plant upon rabbits, but in order to settle the matter even for cows, the Hon. the Minister of Agriculture (Mr. Graham) allowed two cows to be purchased for the purpose, one to be fed upon the plant, and the other to be fed, in the first instance, in the usual way, so as to show by way of contrast the effects of the different feeding. The two cows were placed in separate loose-boxes, and on the evening of October 14, about 6 p.m., one was given half a bag of the freshly cut *Homeria* plant and water, while the other had a good supply of hay and straw. She ate greedily of the plant (although not specially starved for the occasion) while we were present, along with Mr. W. H. Stephen, Acting Chief Inspector of Stock, and Mr. E. Rivett, M.R.C.V.S. On the following day, the cow feeding upon the *Homeria* plant was found to have eaten about half the quantity given her, and refused to have any more. On the 16th she was lying down sick, and on the 17th the same; then on the forenoon of the 18th the cow was killed, and a post-mortem made by Mr. Rivett. This cow was three days and a half under treatment, and the eating of the plant had produced a scouring action, along with general weakness, and a very perceptible trembling at the loins.

The second cow, which was also placed in a loose-box on the evening of the 14th October, was well fed on the 15th and 16th. She was made to fast on the 17th, in order to ensure active feeding, and on the 18th, about 1 p.m., was supplied with about a quarter of a bag of *Homeria*, together with drinking water. She ate very greedily of the plant, and seemed to relish it. On the 19th she was found lying down, unable to rise, and died that night. The examination of the animal was made about mid-day on Thursday, October 20, by Mr. Stephen, in the presence of both of us. The four stomachs were carefully examined, and in the rumen or

paunch, there was marked congestion at the cardiac end, while the mucous membrane peeled off, and was distinctly inflamed. There was also considerable scouring of the animal before death. The stomachs of both cows were found to contain a fair amount of food.

The evidence derived from experimenting upon the cows, supplements that obtained from the feeding of the rabbits.

Conclusions.

To sum up, as far as these experiments go, there are decided indications that the *Homeria* plant has poisonous properties, capable of causing the death of cattle and other animals, and this conclusion is based upon the following grounds:—

(1) This plant is stated to be poisonous to cattle at the Cape, its native habitat, by Professor MacOwan, Government Botanist there, and the probabilities are, that it is so in Victoria.

(2) Several healthy and lively rabbits were fed upon this plant, and with abundance of material they invariably died, while rabbits fed in the usual way remained quite healthy.

(3) A cow fed upon this plant also died, and the symptoms indicated poisoning.

(4) Cows fed in the paddock where this *Homeria* grew died, while those in adjoining paddocks where the plant did not exist, were unaffected.

That the cows ate the plant was shown, not only by the undigested remains found in the stomach, but from the characteristic seed-like bulbils found there, as well as in the droppings.

Government Botanist's Description of Plant.

Baron von Mueller, Government Botanist, has kindly supplied a description of the plant, which is as follows:—

Homeria collina, Vent.—var. *miniata*.—A native of South Africa. Bulb almost spherical, covered closely by a coating of interwoven fibres, between the layers of which numerous minute readily sprouting bulbils are concealed. Whole plant to 3 feet high, but usually much less,

variable also in more or less robustness or slenderness, often somewhat branched. Leaves linear to $1\frac{1}{2}$ feet long to $\frac{3}{8}$ inch broad, but frequently of much less size, always channelled and gradually much narrowed upwards; grey-green above, dark green beneath, slightly streaked, small bulbils also formed occasionally in the axils of some leaves. Inflorescence fascicularly compound when well developed. Somewhat paniculate, the supporting lowest floral leaf often much elongated, clasping at the base. Bracts comparatively long, much pointed, the outer green, the inner smaller, gradually colourless, and very tender. Flower stalks to 2 inches long, though often shorter. Some of the stalklets finally to $1\frac{1}{2}$ inches long, all enclosed in longitudinally convolute bracts. Flowers almost horizontally expanding, very tender, stem shrivelling. Tube of the calyx thinly cylindric, pale-green, darker, six streaked, generally about $\frac{3}{4}$ inch long. Lobes of the calyx three (or exceptionally two), petal-like lanceolar-ovate, about $\frac{3}{4}$ inch long, yellowish towards the base, otherwise almost brick-coloured, or nearly orange-coloured. Petals similar to the calyx-lobes, but somewhat narrower, three (or exceptionally two), along with the calyx-lobes twisted after flowering, finally deciduous. Stamens three (seldom two), much shorter than the calyx-lobes and petals. The three anthers erect, seated on the yellowish narrow staminal tube, about $\frac{1}{4}$ inch long, yellow, broad-linear, blunt, at the base minutely bi-lobed, bursting marginally. Style filiform, about as long as the stigmas. These, as well as the anthers opposite to the calyx-lobes, three (or e. ceptionally two) in number; hardly extending beyond the anthers, yellowish, linear-cuneate, with numerous dilated bi-lobed crenulated and ciliolated summit, and with two small tender inner appendages. Ovulary quite connate with the calyx-tube, three-celled (or seldom two-celled), cylindric and somewhat angular. Ovules very numerous, fixed along the axis. Fruit dry, trigonous cylindric, dehiscent, many seeded. The flowers are distinctly smaller than those of *Homeria collina*, their petals and calyx-lobes are more acute and of a lighter red; also less venulated, and the staminal tube is glabrous.

Conclusion.

It will be seen from the foregoing description what wonderful powers of propagation this plant possesses by

means of its numerous reproductive seed-like bulbils. It can easily be understood how it has overspread the paddock by this means alone. Its showy and attractive flowers likewise rendered it an object of interest and beauty to the numerous wayfarers, particularly on Sundays, and as handfuls of the plant were taken away, it would thus be spread over a large area, and carried to different districts. It is known in other places besides Pascoe Vale, but now that its poisonous properties are unmasked, it is hoped that this brief notice of it may lead to its being promptly destroyed in any garden or cemetery where it may exist.

ART. XIX.—*Report of the Committee of the Royal Society of Victoria, consisting of* PROFESSORS KERNOT, LYLE, and MASSON, and MESSRS. ELLERY, LOVE, and WHITE, *appointed to arrange for the carrying out of the Gravity Survey of Australasia.*

TO THE ROYAL SOCIETY OF VICTORIA.

GENTLEMEN,—In laying before you this, the Second Annual Report, your Committee has much pleasure in informing you that the work of the Survey has now commenced. The pendulums and other apparatus lent by the Royal Society of London—of which a description is appended—have been received, and erected in a cellar at the Observatory, kindly placed at the disposal of the survey by the Government Astronomer. The observing telescope sent with the apparatus proves to be somewhat inconvenient, and it is proposed to employ a different arrangement. The stand for the air-pump was badly packed, and found to be broken on its arrival; otherwise the instruments were in very fair order. It is proposed to devote the next few months to a careful examination of the effects of temperature and pressure on the times of oscillation of the pendulums; such an investigation being rendered especially necessary by the very considerable changes of temperature to which the instruments may possibly be exposed in the course even of a single set of swings. The values of the temperature and pressure coefficients for the pendulums numbered (4) and (1821) were worked out for the purposes of the Indian Survey; but the constants of the third pendulum, numbered (11), have not yet been determined. General Walker assumed them for the purposes of the Greenwich and Kew observations (lately completed) to agree with those of the other two; but your Committee is of opinion that the matter requires further investigation.

The question as to the construction of a new pendulum has received a good deal ot attention from your Committee

during the past year. Fortunately the Royal Society of London has forestalled the discussion, and added pendulum (11) to the two originally asked for. The difficulty and expense attending the construction of a new pendulum has thus been avoided.

E. F. J. LOVE, *Secretary.*

APPENDIX.

Description of the apparatus to be employed in the Gravity Survey of Australasia, by E. F. J. LOVE, M.A.

In drawing up a description of the apparatus, we may consider separately, (*a*) the pendulums, (*b*) the clock, (*c*) the vacuum apparatus and its accessories.

(*a*) The pendulums are, undoubtedly, the most important portion of the apparatus. The three which it is proposed to employ are all constructed of the same materials, and practically identical, both in form and dimension. They are of the kind known as 'Invariable Pendulum." The form is a flat bar of plate brass 5 feet 2 inches long, 0·13 inch thick, and 1·7 inches broad, for a distance of 40 inches from the upper end. The remaining portion of the bar, termed the "tail-piece," is lenticular in section, reduced to a breadth of 0·7 inch, and terminates in a point. Just above the tail-piece is a flat circular brass bob, 6 inches in diameter and 1·3 inches thick, which is fastened to the bar by solder and rivets. The knife-edge is a prism of very hard steel, adjusted perpendicular to the plane of the bar, and attached by means of a stout T head. It is 2 inches long, 0·25 inch in height, and equilateral in section, save that the edge on which the oscillations are performed is ground to an angle of 120°. The planes on which the pendulum oscillates consist of two pieces of polished agate, ground true and set in a heavy brass frame supported on very massive levelling screws. Each pendulum has its own set of planes.

All three pendulums are about 70 years old, and have been repeatedly used for gravity survey work; in which they have given such consistent results as to warrant the belief that they have reached a condition of approximate equilibrium as regards molecular change. For a statement of their history, reference may be made to the "Report of the Great Trigonometrical Survey of India," Vol. V, Appendix p. 30.

With the pendulums is supplied a "dummy pendulum," of identical material and dimensions, into which two holes are sunk for the reception of the bulbs of a pair of thermometers. The dummy is placed in the same vacuum chamber with the pendulum when vibrating, and close to it. Their temperatures may accordingly be assumed as identical, and the temperature of the dummy, as given by the thermometers, can be employed for determining the temperature corrections to be applied to the pendulum. The corrections to be applied to the thermometers have been determined at Kew.

(*b*) The clock employed for the observation of coincidences is a siderial clock, made by Shelton, and was used by Sabine on his expedition in 1822. Its mean daily rate is very constant, but it is subject to rather considerable horary fluctuations of rate. The clock has an arrangement which allows of its being re-wound without loss of driving power during the winding.

(*c*) The vacuum apparatus consists of a cylinder of sheet copper, half closed at the top by a thick brass plate for supporting the agate planes, and closed in above this by a glass bell, ground to fit the brass plate; it is closed at the bottom by a metal hemisphere. It has one glass window about half-way up, through which the thermometers are read, and four others in the plane of the tail-piece of the pendulum. Through one pair the coincidences are observed, the other pair allowing a side view of the tail-piece, which is necessary for determining the amplitude of its vibration. To the sill of the back window is attached a brass plate bearing two scales at right angles to each other etched on ground glass, and with well blackened divisions for measuring this amplitude.

The cylinder is supported by three large levelling screws on a heavy iron girder, which is itself bolted to a very massive timber framework fastened together with iron bolts and clamps. The massiveness of the cylinder and frame render it quite impossible for the oscillations of the pendulum to be communicated to the supports.

The starting and stopping of the pendulum is performed by means of levers worked from outside the cylinder by metal rods passing through stuffing boxes, and cases filled with oil to prevent leakage of air.

A tap attached to the side of the cylinder is connected by rubber tubing to a Siphon barometer, and a second tap allows of the attachment of an air-pump in order to reduce the pressure to any desired amount, which is measured on the Siphon barometer.

As the tail-piece is only a little way above the ground, the short telescope with diagonal eye-piece sent with the apparatus is highly inconvenient. It is proposed to view the coincidences by means of a long telescope of considerable aperture, inclined at a small angle to the ground, and carrying a plane mirror in front of the object glass, so as to reflect the image of the apparatus in a nearly vertical direction. This method will result in a considerable saving of light, and a much more than considerable addition to the comfort of the observer. Anyone who has had experience in really delicate physical work will understand the importance of these considerations to the accuracy of the experiments.

In order that the images of the detached and clock pendulums may be in the same plane, a large lens is provided, by means of which an image of the clock pendulum is thrown on the ground glass scale inside the cylinder. The lens is mounted on a brass angle piece, which slides on a brass frame attached to a wooden stand. The stand rests by means of three levelling screws on a plank bolted to the framework which supports the cylinder.

ART. XX.—*Report of the Cremation Committee of the Royal Society of Victoria, appointed to enquire into and report upon "Cremation" and other methods of disposing of the dead, with particular regard to hygiene and economy.*

TO THE PRESIDENT AND MEMBERS OF THE ROYAL SOCIETY OF VICTORIA.

Your Committee has the honour to report that it has held two preliminary and three general meetings, and has considered the various methods proposed for the sanitary and economic disposal of the dead. Your Committee finds from the evidence collected, that burial now entirely fails to satisfy the demands of hygiene. There are the strongest reasons for concluding that graveyards have been in the past, and are now, prolific sources of deadly disease, not only by reason of mephitic vapours arising thence into the atmosphere, but also by percolation of putrid liquid matter in water drainage to considerable distances. Many cases have notoriously occurred, in which wells have been demonstrably poisoned in this manner at long distances from the source of infection. The risk of this is immensely aggravated as population increases. In America, Europe, and Victoria itself, the towns grow and surround the cemeteries, which soon become full. New ones are formed further away, and the land, being imperatively required by the living, the bodies are unceremoniously removed from the old graveyards, which are generally used for building blocks, public gardens, and other purposes. The removal is a dangerous process, the disturbance of the putrid, poisonous remains having been almost certainly the cause of outbreaks of malignant disease epidemics. It is practically impossible to find a site for a cemetery anywhere in the vicinity of towns, such that there would be no danger to health to the living, in which the air, the water, and the earth of the neighbourhood would be secure from the deadly contamination.

As regards Economy.—The disposal of the dead by burial is already an oppressive charge to the large majority of the population wherever it is numerous. Cemeteries are made further and further away, and the longer conveyance materially enhances the expense, and must continue to do so more and more. The unavoidable crowding of cemeteries has also had the effect of destroying, or outraging, the reverential sentiment which fondly regarded burial as finally providing for the permanent and undisturbed repose of the departed.

After being first filled with corpses to the extent of from twelve to twenty-two (seventy according to the Duke of Westminster—*Times*, December 9, 1889) in each grave, in nearly all old cemeteries, the ground is similarly used over and over again at intervals of a very few years; and the purchase of space for a grave or vault, supposed at the time to secure ownership in perpetuity, is a delusion and a snare; as a matter of fact, headstones are broken up for road metal &c.; the coffins are burned, and the bones used for manure or shot down as rubbish. No respect is shown for the remains of the dead, or for the feelings of their living representatives. All ideas of sanctity and reverence are violated. The use of vaults scarcely delays the process. Persons who have wealth and influence may, if watchful, be able to delay the sacrilege during their lives, but the next generation loses both inclination to resist, and power to postpone it.

The method pursued by the Parsees is much less objectionable hygienically considered. It consists in simple exposure on the top of a tower for vultures to dismember and devour the corpse. This does not engross an increasing quantity of land, or involve the desecration of being dug up again in a few years to make room for some one else, and perhaps of being shot as rubbish. Still less does it, like burial, poison the earth, air, and water, to the destruction of the living; but it is practised by but a small section of the population of India, outside of which it has no advocates, and is not likely to extend.

Desiccation has been recommended, and may be adapted to a very dry climate, but apparently not to others. In the Catacombs at Malta, Palermo, and some other places it has been used; but the results are such as to disgust strangers, and present such features of irreverence and desecration, as to preclude its wider adoption. It may be possible to secure hygienic results by it, but there seems to be much more risk

of the contrary. A movement in favour of desiccation has occurred in America, but your Committee has no reason or wish to think that it has any chance of success.

The use of quicklime has been successfully tried in several instances, where large numbers killed in battle had to be rapidly disposed of, and in some other cases. It does not, however, appear to be adapted for general use, particularly where lime is not readily and cheaply procurable.

Another method has been suggested of disposing of the dead, by simply immersing them in a bath or tank of fused alkali, in which they entirely disappear without leaving any discoverable residue. The cost and feasibility of this method would depend upon the abundance and accessibility of the material, but it seems questionable whether it would ever commend itself to public sentiment. There appears, however, to be no hygienic objection to it.

The expedient, which seems to be in a fair way to supersede burial, is Cremation—an old one revived, and practised widely to-day. Cremation is general in Japan, and in India, where the Government has successfully introduced improved incinerators to expedite and perfect the primitive process in use by the Hindoos. Cremation is the simplest, cheapest, and most hygienic of all; it can be easily effected wherever there are combustibles, and it appears particularly adapted for use in cities, being rapid, economical, final and complete. The residue is small, innocuous, and easily preserved in urns, the cost of which is trifling. Cremation is becoming popular in Italy, where it is rapidly extending. Large numbers are now cremated in Paris, and at Gotha. In England, its progress has been even more rapid than anywhere else, except Rome. At Milan, 679 cremations have been effected in 14 years, but only 227 in the first 7 years. At Lodi, 38 in 13 years. At Rome, where the practice has grown more rapidly than at any other place in Italy, there have been 297 cremations in 7 years. At 21 towns in Italy there were in all 1463 cremations in the 14 years ending with 1890. At Woking, in Surrey, the first cremation took place in 1885, and the numbers since cremated there yearly, are, 3, 10, 13, 28, 46, 54, and 99 in 1891—253 in all; the increase being more uniformly progressive than even at Rome, which began with 15, and ended with 90 in 7 years, and had fewer in 1886 and 1887 than in 1885. The Duke of Bedford, Lord Bramwell, and Mr. Wm. Eassie, were all

cremated during the current year, and Crematories are being established at Manchester, Liverpool, Ilford, Darlington, and elsewhere.

The great advantages of Cremation appear to be—Firstly. the perfect extinction, with the corpse, of the possibility of communication by it of any disease to the living. Secondly, its economy. The cost at Paris is only two francs, and it is less in Japan and India. There is every reason to believe that it could be done in Melbourne for a guinea each at most, including examinations, memorial urn, &c. Carriage must sometimes form a comparatively important item in the cost. It can, however, be much reduced, as portable iron crematories have been successfully constructed for military purposes, and will no doubt come into general use. Thirdly, its finality. Cremation will abolish at once all the shocking desecration which is now inseparable from the burial system. Fourthly, the innocuous residual ashes, less than a quart in quantity, can be preserved in an urn of æsthetic material and device, and deposited either in a public institution (or Columbarium), or confided to the care of the family ; with Fifthly, the satisfactory certainty to all concerned, that the body itself can never afterwards be subjected to disturbance, insult, or desecration, or cause incalculable harm to others.

The only apparently plausible objection that has ever been urged against Cremation is, that the body can never afterwards be available as evidence in cases of murder, particuarly by poison. A case, however, occurred at Milan, which goes far to prove that the risk is actually greater in case of burial (see Robinson, "Cremation and Urn Burial," pp. 177-8). The parents of a deceased child obtained all the certificates necessary for its burial, before resolving to have it cremated. The additional certificates however, which were required at the Crematorium, elicited the fact that the child had been poisoned accidentally by eating sweetmeats containing copper. Your Committee would strongly recommend that no system whatever be tolerated which does not provide amply strict examinations to obviate the possibility of such facts passing undetected.

An Act, legalising Cremation under conditions, has lately been passed by the South Australian Legislature at Adelaide.

Lastly, the legal aspect of the question remains to be considered.

Sir Jas. F. Stephen's judgment in the case of Dr. Price, in 1874, set at rest the question of the legality of Cremation in England, and decided that there was then no law against it there, so long as no nuisance was caused. Of course no system of disposing of the dead should be tolerated, unless all that can be called a nuisance is absolutely prevented. The objection to burial is that it produces evils far worse than nuisances. Since the judgment in question, the Cremation Society of England, though previously deterred by the discountenance of the Home Secretary, proceeded at once to cremate, and has continued to do so since. The same view appears to have been officially taken here, in the Metropolitan General Cemetery Bill, which was introduced by the Government in the Legislative Assembly in 1891, but made no further progress. The existence of this Bill implies that no legal objection to Cremation could be discovered. It provides "for the establishment and management of a Metropolitan General Cemetery" at Frankston, with nine managers; two to be appointed by the Government, and seven to be elected by the Councils of eighteen city and surburban corporations. £20,000 was to be granted from the consolidated revenue to start with, and the corporations were to contribute £2500 a year, until the fees to be charged should amount to a sufficient sum to defray expenses. The cemetery consists of 3008 acres, worth £15,000; distance from Melbourne 26 miles. It is 11½ miles round, and the cost of fencing it has been estimated at £24,000. More thousands are required for a short branch railway. The Bill provides that the managers may make regulations, to be approved by the Governor in Council, prescribing fees for burials, &c., and also for cremations. Section 71 provides that any one may direct by Will or otherwise, that his body shall be cremated, and that his executors or others may carry his direction into effect, in the cemetery, under regulations to be made under Section 77. The admission that Cremation is not illegal is something, and the attempt to legalise it is more. But cremation at a distance of 26 miles is useless. There is ample proof that its proper performance within a city admits of no reasonable objection. Persons living next door would not even know that it was in progress, and in itself it is essentially purifying as well as innocuous.

Hygiene demands the reduction to a minimum of the time and distance between the death of the body and its

final disposal. One weighty objection to burial is, that it must be as far from the city as convenient, notwithstanding the cruel inconvenience and expense to the mourning relatives in the performance of their sacred duties. Their strong claims to sympathy and consideration appear to have been wholly ignored in the Frankston scheme. But in Melbourne now, hundreds of pious mourners visit the graves of their departed relatives weekly, and even more frequently, to plant and carefully tend flowers around them. They would be cruelly debarred from performing this pious duty by the extra cost and time involved in frequent journeys, even by railway, of 52 miles. Cremation would abolish this difficulty entirely. Instead of having to neglect these duties altogether, or to travel, say weekly or daily to Frankston to fulfil them, they would have the actual pure ashes themselves, in an elegant urn or other receptacle, in either the mortuary chapel, or family household, where they could fulfil their cares and soothe their feelings by daily viewing them, and decking them with fresh flowers.

As regards economy, compare a central City Crematory and Mortuary Chapel, costing perhaps £2000 or £3000, and 2s. 6d. or 3s. worth of fuel, and a fee of a guinea, with a Cemetery 26 miles off, costing for land £15,000, fencing £24,000, and several thousands more for a branch railway to it. But these are of minor importance concerning the state contribution only. The salient point is, what will be the charges for each funeral to bereaved mourners—the people? The deaths in Melbourne may now be taken at 10,000 yearly (10,412 in 1889, and 9,297 in 1890, Hayter), *i.e.*, 25 to 28 daily. £10 is surely a low average for ordinary funerals now, and transport is always and necessarily, a formidable extra; and however performed, the 26 miles cannot but add largely to the expense, falling upon the unfortunate mourners in the shape of undertakers' bills, thus augmented by at least 25 or 30 per cent.

The fees, also, of unknown amount, would also fall upon them, and to provide the projected embellishments upon the scale hinted at, the fees must be anything but light. Even supposing that the increase altogether might not exceed 50 per cent., £15 for each funeral, multiplied by 10,000, would be at least £150,000 to be paid yearly *by the people*, beside the contribution of the state. Cremation would perform the whole service for probably £1 1s. each, or £11,000 a year, in a few crematories costing perhaps £2000 each.

Your Committee for all these reasons confidently recommends Cremation as incomparably the best solution of every difficulty, particularly on hygienic, sentimental, and economical grounds.

Your Committee, however, also feels called upon to remark here that not only in the Bill in question, but also in the Cemeteries Act of 1890 (No. 1072, now in force), some of the most important facts which should be kept in view in disposing of the dead seem to have been entirely ignored. Its framers appear to rely, with most mistaken confidence, upon hermetically closed coffins and cemented vaults to prevent the escape of the poisonous gases generated in decomposition. This is a fallacy. *Such escape cannot be prevented.* Your Committee cannot do better than repeat the decisive testimony of Sir John Simon, the eminent Sanitarian (quoted in the Duke of Westminster's letter to the "*Times,*" dated December 9, 1889):—

"The leaden coffin sooner or later yields, and gives vent to its fatal contents. The most successful attempt at hermetical enclosure does not reach beyond postponement of the effusion through the atmosphere of the products of decomposition. Overcrowding the dead causes the soil to be saturated and supersaturated with decomposing animal matter, polluting the water-springs and vitiating the air; and it is by the air, vitiated by organic matter undergoing decomposition, that epidemics and infectious diseases most readily diffuse their poison and multiply their victims."

Your Committee has made its deliberate recommendation upon the evidence before it. It is perhaps scarcely necessary to say that that recommendation does not include that those who prefer burial should not be as free as the advocates of cremation to do what *they* prefer. At the same time, it seems clear that both the *public* advantages of cremation, and the *public* dangers of burial, are infinitely more important and practical than any *private* predilections either way.

(Signed)

LLEWELLYN D. BEVAN, D.D., Member.
J. TALBOT BRETT, M.D., ,,
D. A. GRESSWELL, M.D., ,,
WILLIAM C. KERNOT, M.A., ,,
WILLIAM LYNCH, ,,
ORME MASSON, M.A., ,,
WILLIAM L. MULLEN, M.D., ,,
JAMES EDWARD NEILD, M.D., ,,
G. A. SYME, M.D., ,,
H. K. RUSDEN, Hon. Secretary.

Art. XXI.—*Report of the Port Phillip Biological Survey Committee*, 1892.

Your Committee regret that there are no results to report as received from the specialists in Europe to whom material was forwarded, though we have information that the work is in hand. During the course of next year, Professor Spencer, who is on the Committee, is visiting Europe, and hopes to arrange for an early publication of the descriptions.

Professor Tate, of Adelaide, has returned the specimens of the Nudibranch Mollusca, as he finds himself unable, through pressure of other duties, to undertake their determination.

Dr. Dendy has continued his studies on the Sponges, and has worked out the classification and much of the detailed anatomy of the Calcarea Heterocœla. He is publishing a Synopsis of this work in the Proceedings of our Society, and anatomical accounts in the European journals.

Your Committee have incurred no expenses during the year.

A. H. S. Lucas, *Hon. Secretary.*

Nov. 8, 1892.

MEETINGS OF THE ROYAL SOCIETY.

1892.

[N.B.—The remarks and speeches in the discussions are taken down verbatim by a shorthand writer, and afterwards written out at length with a typewriter, for reference and reproduction, if required; and therefore, more is seldom given herein than an indication of their general drift. If any person should wish to refer to the verbatim report, he can apply to the Secretary to the Society, who will give him an opportunity of perusing and copying it, or if he resides at a distance, so much as he requires will, upon payment of the cost of reproducing it, be forwarded to his address.]

ANNUAL MEETING.

Thursday, March 10th.

The President (Professor KERNOT) was in the chair.
The minutes of the last meeting were read and confirmed.

ELECTION OF OFFICE-BEARERS AND MEMBERS OF COUNCIL.

The following Office-bearers and Members of Council were duly elected:—President—Professor W. C. Kernot, M.A., C.E. Vice-Presidents—E. J. White, F.R.A.S., and H. K. Rusden, F.R.G.S. Hon. Treasurer—C. R. Blackett, F.C.S. Hon. Librarian—A. Dendy, D.Sc. Hon. Secretaries—Professor W. Baldwin Spencer, M.A., and A. Sutherland, M.A. Members of Council—J. E. Neild, M.D., C. A. Topp, M.A., LL.B., Professor Laurie, LL.D., R. L. J. Ellery, F.R.S., G. S. Griffiths, F.R.G.S., Professor Orme Masson, M.A., D.Sc., H. Moors, Rev. E. H. Sugden, B.A., B.Sc.

The PRESIDENT referred to the services rendered in past years to the Society by the retiring Librarian, Dr. Neild.

Annual Report.

The following Report and Balance Sheet were taken as read, and on the motion of Mr. Ellery, they were adopted:—

The Council of the Royal Society herewith presents to the Members of the Society the Annual Report and Balance Sheet for the year 1891. The following meetings were held, and papers read during the session :—

On the 12th March, at the Ordinary Meeting held after the Annual General Meeting, T. S. Hall, M.A., "On a New Species of Dictyonema ;" A. Dendy, D.Sc., "A Preliminary Account of *Synute pulchella*, a New Genus and Species of Calcareous Sponge ;" T. S. Hall, M.A., and G. B. Pritchard, "The Geology of the Southern Portion of the Moorabool Valley."

On the 2nd April, R. Etheridge, Jun., F.G.S., and A. Smith Woodward, "On the Occurrence of the Genus Belonostomus in the Rolling Downs Formation of Central Queensland."

On the 11th June, Professor W. Baldwin Spencer, "On the Anatomy of *Ceratella fusca* ;" A. Dendy, D.Sc., "Additional Observations on the Victorian Land Planarians ;" A. H. S. Lucas, M.A., B.Sc., "On a New Species of Fresh Water Fish from Lake Nigothoruk, Mount Wellington, Victoria ;" Professor W. Baldwin Spencer, "Land Planarians from Lord Howe Island."

On the 9th July, A. Dendy, D.Sc., "Description of a New Species of Land Nemertean (*Geonemertes australiensis*) ;" R. L. J. Ellery, F.R.S., "The Present State of the International Photographic Charting of the Heavens."

On the 13th August, A. Dendy, D.Sc., "On the Mode of Reproduction of *Peripatus leuckartii* ;" A. Dendy, D.Sc., "Short Descriptions of New Land Planarians ;" Professor W. C. Kernot, "Notes on the recent Flood on the Yarra."

On the 10th September, G. B. Pritchard, "On a New Species of Graptolitidæ ;" A. Dendy, D.Sc., "On the Presence of Ciliated Pits in Australian Land Planarians."

On the 8th October, A. H. S. Lucas, M.A., "Notes on the Distribution of Victorian Frogs ;" R. L. J. Ellery, F.R.S., "Notes on the Magnetic Shoal near Bezout Island, North West Australia."

On the 12th November, G. S. Griffiths, F.R.G.S., "The Geology of Barwon Heads;" A. Dendy, D.Sc., "Description of some Land Planarians from Queensland."

On the 10th December, Professor W. Baldwin Spencer, "Preliminary Notice of Victorian Earth-worms. Part I—The Genera Megascolides and Cryptodrilus;" H. H. Anderson and J. Shephard, "Notes on Victorian Rotifers;" Professor W. Baldwin Spencer, "Note on the Habits of *Ceradotus forsteri.*"

The following Members and Associates were elected during the year:—Members, A. Dudley Dobson, J. W. Barrett, M.D.; Country Members, John Desmond, John Dawson; Associates, W. J. Strettle, W. L. Mullen, M.D., Miss Agnes Ross Murphy.

Your Council regrets to have to record the loss by death of the following Members of the Society:—Hon. J. G. Beaney, J. P. Bear, Henry Edwards, Johnson Hicks, G. LeFevre, M.D., John Wall, Hon. Sir Wm. McLeay, the Right Rev. Charles Perry, D.D.

During the course of the year, your Council received with great regret the resignation of A. W. Howitt. Though this was necessitated by pressure of official duties, it is hoped that Mr. Howitt may before long find himself again able to take an active part in the work of the Society. A. Dendy, D.Sc., was elected by the Society to fill the vacancy thus created.

During the course of the year, also, J. Cosmo Newbery, B.Sc., who was leaving for England on a scientific commission, resigned the Vice-Presidency of the Society, and H. K. Rusden was unanimously elected to fill the vacant office. From 1870-77, and again from 1886-91, Mr. Rusden had been closely identified with the Society in his position as one of the Hon. Secretaries, and in nominating him for the post of Vice-President, the Council expressed its warm appreciation of the services which, in the capacity of Secretary, he had rendered to the Society, in the work carried on by which he had taken an important and active share.

The Librarian reports the addition to the Library during the year of 1076 publications. It may be noted that a Manuscript Catalogue of the Library has now been drawn up rendering it more available for reference. The Assistant

Librarian is in constant attendance to afford assistance to those desirous of consulting the volumes. Your Council has had under consideration the exchanges which are made with other Societies and hopes to be able, in the future, to add considerably to the value of these in consequence of the increased amount of publications which now emanate from the Society.

The most important publication of the year has been that of Part I of Dr. Dendy's "Monograph of the Victorian Sponges."

The Committee appointed by the Council to distribute the collections of animals obtained from Port Phillip experiences very great difficulty in obtaining any information from specialists at home to whom the various collections have been sent for investigation. It hopes, however, to obtain reports during the coming year, and is endeavouring to hasten the work, though this must naturally take a long period of time in completion. The Council desires to place on record its high appreciation of the labours of J. Bracebridge Wilson, Esq., M.A., by whom the collections have almost entirely been made.

As will be seen from the list of papers read before the Society during the past year, a considerable number of original scientific investigations have been carried on by Members. Your Council trusts that the amount of work recorded in its publications may increase year by year.

Dr. *The Hon. Treasurer in Account with the Royal Society of Victoria to March 1, 1892.* **Cr.**

To Balance from 28th February, 1891				£342	14	6
,, Government Grant—						
Balance of Vote for 1890-91	£150	0	0			
Instalments for 1891-92	250	0	0			
				400	0	0
,, Entrance Fees				10	10	0
,, Subscriptions—						
Members	160	13	0			
Country do.	29	8	0			
Associates	54	12	0			
Arrears	2	8	0			
				274	1	0
,, Rent of Rooms				14	5	0
,, Sale of Transactions				0	7	6
,, Interest				33	0	0
				£1,074	18	0

By Printing and Stationery	£579	17	0
,, Rates	4	15	0
,, Gas and Fuel	9	14	2
,, Salary, &c., of Assistant Secretary	72	18	4
,, Shorthand Records	11	11	0
,, Hall-keeper's Allowance	6	0	0
,, Collector's Commission	34	8	7
,, Insurance	3	10	0
,, Postages	37	15	0
,, Repairs and Furnishing	8	15	0
,, Books and Periodicals	38	17	6
,, Freight	8	16	9
,, Refreshments	5	12	6
,, Binding	25	1	0
,, Incidentals	9	15	0
,, Interest	1	8	11
,, Balance, 28th February, 1892	216	2	3
	£1,074	18	0

Dr. PUBLISHING AND RESEARCH FUND. Cr.

To Fixed Deposit in Bank	£300	0	0	By Fixed Deposit in Bank of Australasia	£300	0	0
,, Interest on same	15	0	0	,, Interest transferred to General Account ..	15	0	0
	£315	0	0		£315	0	0

Compared with the Vouchers and Bank Pass-book and Cash-book, and found correct,

C. R. BLACKETT, (Signed) H. MOORS, Auditor.

Hon. Treasurer. *26th February*, 1892.

Professor SPENCER, in accordance with notice of motion, moved the repeal of Rules 52 to 58 inclusive. He did not think the Society was large enough to be broken up into Sections, and further, such breaking up would affect the Society's maintenance and welfare as a whole. In his opinion, Sections could not be carried on with any benefit to the Society, as a number of their members interested in any particular work set themselves apart and formed what was practically an independent Society, and the Council which must be the central authority lost control over the actions of members. Their experience of the Sections which had already been in existence was such as to create a feeling against their continuance, and in favour of merging all into one Society working together as one body.

Mr. ELLERY seconded the motion. Until he had had practical experience of the working of Sections he had favoured their establishment, but he was now of the opinion that they tended to lessen interest in the doings of the parent Society and to reduce the attendance. He thought it would be wise to abandon the Sections, at all events until the Society became very much stronger. The Royal Society of London had no Sections. Should the motion be carried, they should not interfere with existing Sections until the lapse of a certain period.

Mr. WHITE considered that if the Sections had been kept under control no trouble would have been occasioned. As the Rules provided that the Council "may" prevent the formation of Sections, there was no need for the resolution.

Mr. BLACKETT referred to the merging of the Microscopical Society into the Royal Society, and probably it might be considered by members of the former body, which was afterwards carried on as a Section of the Royal Society, that they had been somewhat unfairly dealt with. He agreed with others that the Sections had been somewhat unsuccessful.

Mr. SUTHERLAND supported Mr. White's view. There was no necessity for the motion, the object of which was merely to get rid of Section G. It could not be expected that people would attend the ordinary meetings of the Society and listen to some abstruse paper on a subject they knew nothing of, while they waited for the paper to be read in which they were interested. Royal Societies were not favourable fields for special papers in any particular branch, although many people were good enough to attend meetings

and suffer the infliction of hearing papers read in which they had not the slightest interest, and so provide audiences for the readers. If it was intended merely to get rid of Section G, then Section G had no desire to remain if it was not wanted, and it had already taken steps to withdraw. The Engineering and Physical Sections had had meetings which were rendered more pleasant than any mixed meetings could be. It should be borne in mind that the Sections acted as feeders to the general Society.

Dr. DENDY considered that the more the Sections were increased so were the expenses. The Council practically lost all control over the Sections.

Professor SPENCER said that his motion was general, and did not apply to any particular Section. They had given Sections a fair trial, and he did not think they had been a real success.

Professor ORME MASSON said that if the motion were carried, it did not follow that Section G could not remain. He would urge that the motion be carried, for the reason that it would not be an arbitrary abolition of any existing Section. It would simply be a certificate from the Society that it did not care to create new Sections.

Mr. ELLERY drew attention to Rule 54, which provided that meetings should be for scientific objects only. If that Rule had been kept in view, all difficulty might have been avoided.

Mr. JAEGER hoped that the abolition of the Rules would not preclude the reading of any papers on Art.

Mr. ELLERY.—Certainly not. The formation of Section G was the result of many years' discussion. It was urged that Art and Literature should be more thought of in the Society than they were.

Mr. RUSDEN thought it was hard to suppose that the Rules were framed without consideration and wisdom. Rule 30 provided against anything objectionable occurring in any Section, and that Rule had been overlooked. If it had not been overlooked, no paper would have been read without being submitted to the Council.

Mr. WHITE agreed with Mr. Ellery that the Society was not strong enough for Sections. As the Council had the right of vetoing Sections, why not leave the matter to it.

The PRESIDENT'S opinion was that the passing of the motion would not abolish existing Sections, but would take away the power of establishing new Sections in the future.

Professor ORME MASSON said that the passing of the motion would show that the Society was against having Sections, and the result would in all probability be that Section G would abolish itself.

Mr. SUTHERLAND said that Section G did not intend to abolish itself, but to sheer off and have an independent existence.

Mr. BLACKETT mentioned the fact that no minute books had been kept by the Sections.

Mr. WHITE moved "that in the present state of the Society the formation of Sections was not advantageous to it, and that in the future no Sections be allowed."

Mr. RUSDEN.—The Society should request the Council not to appoint Sections.

Dr. JAMIESON was opposed to the formation of Sections, as the more numerous they were, the more they tended to impoverish the Society. It was not necessary, in his opinion, to alter the Rules, as in accordance with the sentiments expressed that evening the Sections would be abolished.

Professor LAURIE could not understand why it was necessary to legislate for the future.

Professor SPENCER'S motion, on being put, was carried.

Mr. Albert Swanson and Mr. J. B. L. Mackay were elected as Members.

Mr. G. B. Pritchard and Mr. L. J. Balfour were nominated as Associates.

The Librarian's Report showed that 203 publications had been added to the Library since last meeting.

Professor SPENCER gave a summary of his paper on "Victorian Earthworms. Part II. The genus Perichæta."

The PRESIDENT wished to know if Professor Spencer agreed with Darwin's theory of the production of the humus.

Professor SPENCER thought that the work done by earthworms in other countries was largely done by ants here.

Thursday, May 12th.

The President (Professor KERNOT) in the chair.

The minutes of the last meeting were read and confirmed.

Mr. Wilsmore, Associate, signed the Roll.

Mr. W. H. Archer and Dr. J. W. Barrett were elected as new Members of Council, from which Dr. J. E. Neild had retired.

Mr. R. J. A. Barnard, M.A., and Mr. G. B. Pritchard, were elected as Associates.

The Librarian's Report showed that 191 new publications had been added to the Library since the last meeting.

Mr. MARTIN GARDINER'S paper on "Confocal Quadrics, &c.," was taken as read.

Dr. DENDY read a paper entitled "Further Notes on the Oviparity of the larger Victorian Peripatus, generally known as P. leuckartii."

Mr. ALEXANDER SUTHERLAND read a paper on "The Responsibility of Criminals."

Mr. ARCHER said that they had heard Mr. Sutherland's very able and comprehensive address, which was however full of contestable points. Mr. Sutherland's conclusion appeared to be, that while it was a gross act of injustice to punish a man for what he could not help doing, yet he must be punished because it would not be right to stick to abstract justice. The word "responsible" was used a number of times in the paper, but if a man could not help himself, how could he be held to be responsible? Although Mr. Sutherland had stated that the incorrigible boy at school had no more right to be punished than a Maori should be for having a brown skin, yet he afterwards said that the boy ought to be punished because it would assist him in forming his character. Did not that indicate on the part of the youth a sense of right and a power of self-control? As to lunatics in asylums, it was known that a large proportion had what were called lucid intervals, during which their medical attendants would reason with them and treat them as intelligent men. That was a proof that they recognised in their patients a power of distinguishing right from wrong, and of exercising a control over their actions. They could determine to do what they saw was right.

Professor LAURIE considered there were some points in the paper which must inevitably give rise to difference of opinion, and he was rather sorry it had raised the question of free-will. Discarding free-will, and holding any doctrine that might be preferred, it was not necessary to go to the opposite extreme and to say that every person who fell into crime was to be regarded, not as an object of blame, but solely of pity. The fact was, that persons who did wrong frequently blamed themselves, and admitted that they deserved punishment. That showed that they could not wholly do away with the sense of blame for wrong done. Mr. Sutherland's great point should not be lost sight of, namely, that the aim of government in inflicting punishment was to deter crime. The aim of government should be to suppress crime, and it was justified in doing all it could to attain that object. Punishment, or the fear of punishment, was a great factor in suppressing crime—in preventing a person who contemplated committing crime from falling into it. At least, that should be the aim of punishment. He was entirely in accord with Mr. Sutherland, that government was entitled to say how it was best to inflict punishment, but at the same time he did not see any reason why the moral aspect of crime, even from the deterrent view, should be omitted. It was quite true that people were swayed by fear of punishment, but when the State laid down certain rules, the violation of which would lead to punishment, it did not hold out a threat to deter people from doing what they would otherwise like to do. To many people, the State was an embodied conscience. People did not come into the world knowing what was right or wrong, nor did they evolve propositions as to right or wrong from their personality; they were taught by others, and in a great measure by the laws of the State, as to what was right or wrong. A great many people regarded the laws which the State had laid down with regard to crime as laws which, from a moral point of view, should not be transgressed, so that the deterrent power of the State appeared to him to act, not only from the fear of punishment, but also because of a moral standard which the majority of people adopted, and which they were not likely to transgress. It should be borne in mind, that the punishment inflicted by the State for crime, so far from reforming the criminal, had the opposite effect, and it was a question worthy of consideration whether the State should not adopt

some form of restriction adapted to the various needs of those with whom it had to deal. There were, undoubtedly, persons in whom hereditary traits were very strong, who were borne almost irresistibly towards crime, and for the security of society the State might deal with those persons in a different way from that in which others were treated. Still, with regard to a great number, it should be borne in mind that the humanitarian spirit of the age demanded that the possibility of reformation should be kept in view. The trend of modern thought was away from the old idea of retribution; but he thought they should recognise the elements of truth, even in that old theory of retribution, and the elements of truth were, that when something was committed which was regarded as criminal—acts of violence or fraud—there was a healthy feeling of resentment. He did not think that feeling should be suppressed, though it should be woven in with the other ideas of reformation. It should also be borne in mind that, when men were punished, they very frequently felt that they deserved it. While he thoroughly agreed with Mr. Sutherland that the State was perfectly warranted, for the suppression of crime and the protection of society, in adhering to any punishments which had been adopted to bring about this aim, he did not think, on consideration of the whole question, that the moral aspect could be entirely left out.

Dr. JAMIESON agreed with the conclusion arrived at in the paper, that punishment must be inflicted without yielding to any particular philosophical opinions one might hold about free-will. The crux of the question related to capital punishment. If that punishment was to be applied mainly for deterrent purposes, and for its influence on others for reformative purposes, was it not absurdly unfair that it should be inflicted on a person who was held not to be fairly responsible for what he did. It was a question how far capital punishment was allowable at all on any supposition of necessitarianism. A School of Criminal Anthropologists was in existence, who were prepared to carry out their ideas to perfectly logical conclusions—especially what was called the Italian School. Lambrosa went so far as to lay down as a principle that there are instinctive criminals, and that it was as absurd to punish such a person as it would be to punish a person for having small-pox; that there existed no right in any sense of the word to punish such a person for retributive or deterrent purposes. He thought the common

sense of most people would incline them to object to that view, as being an extreme and dangerous doctrine. It was based very much on the assertion or opinion, that the criminal was a criminal in virtue of a certain defective construction of his brain; that the proof of that consisted in the fact that, given a certain number of persons who were known to be criminals, it would be found that they had smaller heads than the average person; that they had a less facial angle; that the top part of their face and head sloped backwards; that their head, on the average, was a little wider transversely—being wide relatively to its length; that such persons, on the average, had badly shaped ears; that the ridge over the eyes projected; that in very many of them there was a secondary ridge above the eye-brows, which was very prominent; that in a considerable number of them the lower jaw was largely developed, and projected in front of the under jaw. Whilst that generalisation might be freely admitted, it was dangerous to apply the test to individuals. There had been notorious criminals in existence whose heads were full sized, whose facial angle was good, whose ears were good and whose jaws were in proper position, and it would be altogether unsafe to base a man's responsibility for certain acts he had committed on the size or shape of his head. An attempt was undoubtedly being made to popularise that doctrine at the present time, and to say that given a man who exhibited a certain shape of head, who had imperfectly formed ears, who had prominent ridges over his eyes, and so on, and given the further fact that he had committed a crime, that that man should be held to be irresponsible, and should not suffer the consequences of his crime. The conclusion seems to be, that the criminal type of person represented a degenerated type—a development of the lower type, with brains constituted similarly to those of the lower race, and therefore should not be held responsible for doing any wrong act. He thought it would be extremely dangerous to allow a doctrine of that kind to be carried to its logical conclusion. Popular opinion was easily led astray in a similar matter, namely, the influence on the brain of disease or of injuries to the head, and the probability that thereby a man would be rendered irresponsible. It was perfectly true that disease of the brain was almost certain to interfere with a man's intellectual capacity, and would make him incapable of controlling himself. That general principle might be admitted; but it was dangerous and absurd to infer that, when a

man was suffering from any kind of disease, he was to be held to be irresponsible. It was known, that there were structural diseases of the brain that did not necessarily involve the mental faculties. That the mental faculties were affected to a considerable extent was well known, but it was absurd to infer irresponsibility, and to declare that a man was not to be punished for his wrongful acts. Especially did it become dangerous and absurd when it was attempted to apply the doctrine to individuals. It was extremely dangerous to apply the doctrine of anthropology to criminal cases. In spite of recent discoveries, we did not know half as much as we would like to know about the functions of the brain, or as much as we hope some day to know. Physiologists know that there are parts of the brain that are well defined, that there are parts that control movements, that there are parts which deal with hearing, speech, and sight, but when it came to the question of learning what particular part of the brain is exclusively concerned with the mental faculties, they would have to depend on what was little more than inference. It was probable that the front part of the brain is that which is concerned with the intellectual and moral faculties. There might be extensive injury to that front part of the brain—parts of it might be lost or degenerated as the result of disease—but he did not know that it always followed that the mental or moral faculties were deteriorated in proportion to the amount of brain lost. The average unscientific person was apt to apply to individual cases, apparently logically, but still dangerously and unfairly, the scientific generalisation, which was fair enough as regards a particular disease. As to the measure of responsibility of people unmistakably insane, that was a difficult question, with which he was not then prepared to deal.

Dr. MULLEN said it was absolutely necessary that lawyers should act on precedents. It was far more important that the law should be as certain as it could be, than that it should be just. There were many points in it that were unjust, but the prerogative of mercy could be exercised by the Crown. Of course the law was the true embodiment of everything that was excellent, and it did not deal with motives. Although the motive for an act might influence the amount of punishment inflicted, it could not influence the responsibility of the person who had done wrong. The responsibility of criminals was mixed up with the most important question of the protection of society. If a man

had stolen a £5 note, he would join in the cry against the wrongdoer, because others might steal a £5 note from him. He unhesitatingly said that the modern idea of the responsibility of criminals, and consequent punishment, was not the best way to protect society. In the beginning of this century nearly all the felons were hanged, and the adventurous spirits were drafted off to the wars. The consequence was, to use a vulgar expression, that the breed was stopped. Now, however, owing to the manner in which felons were treated (imprisonment for a short period), there was being developed a race as devoid of moral sense as a child born blind was of sight; it was nothing less than propagation of the species. We were developing a typical immoral race; and if anyone were to go to the East end of London and pick out ten children of from 8 to 10 years of age, he could predict with tolerable certainty what would become of nine of them, partly by heredity and partly by surroundings. The question to be considered was not so much their responsibility, because the law made them responsible, but how were they going to protect society from criminals. He would not enter into the discussion of such questions as free-will, because they were not practical. As to the responsibility of the insane, that was a question to which it was impossible to give an answer. He might as well ask the President if a bridge over the Yarra were injured, what strain it would bear. The President would want to know what bridge it was, the particular kind, the size and other things which to an ordinary layman would look absurd, and experts would differ as to the amount of strain. He might as well ask Mr. Sutherland how long it would take for a boy to construe a chapter of Cæsar. He would want to know all about the boy and his class, and what chapter was referred to. When they came to speak of lunatics, each case must be considered singly. The law did not recognise that there were dozens of forms of insanity which ran into one another. Originally, there was but one class of insanity. Then the law took note of delusions, but it stopped there; a mad man was either a maniac or delusionally insane. Those laws were laid down by very worthy gentlemen, who knew nothing but what they found by metaphysical reasoning in the four corners of their rooms. Mr. Sutherland had laid down rules for the guidance of lunatic asylums; the Act of Parliament did not allow the medical officers to punish any lunatic.

Lunatics, knowing that they could not be punished, did not commit crimes. He knew the case of one inmate who would say to the doctor at times, "if you don't lock me up, I will do something." The older warders would say, "I think you had better lock him up." Such men knew when the impulse to do some violent act was upon them, and knew it could not be resisted. Then in puerperal mania, he had known a woman to say, "doctor, if you don't take the child away, I will kill it; if the servant goes out, I will kill it." The woman was perfectly aware of the illegality of the act, but could not help herself, but even the presence of the servant girl would deter her. That was a strong case, as it appealed to the sentiments. In order to show that the punishment of a criminal, sane or insane, would not deter others, he referred to the case of a woman in Brunswick who, on the same night that Deeming was condemned to death, deliberately, as far as a lunatic could act deliberately, went into a house and exploded dynamite, and when she was about to be arrested she tried to blow herself up. The lawyers would say she was partially insane, whatever that might mean; she certainly had a sufficiency of reason to know right from wrong, but the punishment of the other criminal had no deterrent effect on her. Mr. Rusden had alluded to the fact, that lunatics and criminals received the same punishment, viz., incarceration. He supposed there was no sane man living who would care to be locked up as a patient in an asylum, but it was certain that that punishment had never prevented a man from going insane. As to the punishment of lunatics, some were responsible and some were not, but that was a matter on which, as to justice, they should go to experts. As to the protection of Society, he would say they were responsible. In the present state of the law, the judges get out of the difficulty as best they can. In a case of puerperal mania, in which the patient admitted to the doctor that she knew she was doing wrong, the judge said to the jury—"Gentlemen, she said she knew she was doing wrong, but it is for you to say whether she meant what she was saying." That was the way in which he got out of the difficulty. The question of sudden impulse is a dangerous one to deal with. The question ought to be—"Has this man got brain disease; has he got a certain kind of brain disease affecting certain functions? Yes." The lawyers did not take it that way. They seized upon the metaphysical point of right or wrong.

The law said that, if the man had a sufficient idea of right or wrong, he was responsible. The Executive sometimes stepped in and, as he thought, wrongly pardoned the man who was a danger to society. In one of our asylums there was a terrible case of homicidal mania, and in his opinion, that man should be removed simply for the protection of society.

Mr. RUSDEN called attention to an article in the *Forum*, on the Elmira Prison in America. The conclusion it drew was that, while the population was increasing three per cent. the criminality was increasing fifty per cent., and the writer attributed that result to the humanitarian treatment of criminals.

After a few words in reply by Mr. SUTHERLAND, on the motion of Colonel GOLDSTEIN, seconded by Professor ORME MASSON, the discussion was adjourned to the next meeting.

Thursday, June 9th.

The President (Professor KERNOT) occupied the chair.

The minutes of the preceding meeting were read and confirmed.

Mr. J. B. Pritchard, an Associate, signed the Roll and was introduced to the meeting.

The LIBRARIAN reported that 114 publications had been reeeived since the last meeting.

Mr. SUTHERLAND read a paper "On the Nest and Eggs of the Victoria Rifle Bird" (Ptilorhis victoriæ), by Mr. D. Le Souëf.

The discussion on "The Responsibilty of Criminals" was resumed.

Colonel GOLDSTEIN said that, in continuing the discussion of Mr. Alex. Sutherland's paper on "The Responsibility of Criminals" read at the last meeting, it would be necessary to state a few of the difficulties that occurred to the unscientific public mind, which tended to prevent the formation of just opinions on the subject. One difficulty was the great divergence apparent between the views advanced by those

scientific and professional gentlemen to whom the public looked for advice. Our legal luminaries held the view that all men were responsible for their crimes, except in the case of acute mania, when it could be proved that the accused did not know the difference between right and wrong; while the medical fraternity, though by no means unanimously, urged irresponsibility whenever there was any form of brain disease, no matter how slight, or even where it was only suspected. It was as well, perhaps, for the general well-being, that society was still willing to accept the guidance of our legal, rather than of our medical, friends. But as theories that were flung broadcast among the people were certain to obtain some adherents, and as such theories, if largely appealing to our sympathies, might lead to dangerous changes in public opinion, it was well that scientific societies should meet and discuss all such theories, for the benefit of the public, and in order that our laws might be wisely ordained; law being the crystallisation of public opinion. Another difficulty arose from confusion in the terms used, and their true significance. For instance, "retributive punishment" was frequently described as "revenge," which of course was quite incorrect; yet many writers, Mr. Sutherland also, used the phrase in this sense. Then there was the extremely narrow view advanced by some writers that, early in the world's history, punishment was retributive only; that later, it was sought to be made deterrent; and that as it had failed to be deterrent, it should therefore seek to be reformatory only. He alluded to this as a narrow view, because he hoped to indicate presently that punishment should partake of all three qualities—that it should be retributive, deterrent and reformatory. There was another difficulty that must frequently occur to the unscientific mind, how to reconcile such statements as Mr. Sutherland's, that "the treatment of criminals was not a matter of abstract justice, but of pure policy. It was not concerned with ethics, but with the preservation of law and order." Spencer laid down as the fundamental law of human justice, "that each individual ought to receive the benefits and the evils of his own nature and consequent conduct; neither being prevented from having whatever good his actions normally bring to him, nor allowed to shoulder off on to other persons whatever ill was brought to him by his actions." The question of the respon-

sibility of the criminal was a large one, and was to be looked at critically from so many points of view, that it was only by long and patient study we could hope to solve it, and to measure out punishment to the criminal, with the view to the gradual reduction of crime. So much was this felt, that it had justly been considered necessary to examine the criminal class in a thoroughly scientific manner. Hence the new Science of "Criminal Anthropology," which had led to the holding of International Congresses, the first of which had been held at Berne in 1885, the second in 1889 at Paris, and the third was to be held this year at Brussels. There had also been established a few years back the International Criminological Association. An enormous amount of useful work had been done, but the new Science was only in its infancy. Numerous articles and books on this subject had been published in Europe and America, so that the first results of enquiry were within reach. Havelock Ellis, in 1890, had published a book called "The Criminal," which was a valuable compilation of the opinion of those who had taken a leading part in the work. His (Colonel Goldstein's) attention had been directed to three articles in the "International Journal of Ethics," which fairly represented some of the views held. One was "The Theory of Punishment," by the Rev. Hastings Rashdall; another "The Prevention of Crime," by Dr. Tönnies; and the third was a discussion on these by Professor James Seth, of Dalhousie College, According to Professor Seth, the new Science of Criminology was founded on the theory that crime was a pathological phenomenon, and that the proper treatment of the criminal was, accordingly, that which sought his cure rather than his punishment. He claimed that this was an advance in human feeling as well as in intelligence. It might be suggested that, as these latter day views of criminology were the result of special studies, or studies by specialists, we should do well to raise the question, were specialists, as a rule, well trained in philosophy. Or, to put it more distinctly, had these particular specialists any fair amount of knowledge of the ultimate causes of the various phenomena of the universe? Because so far as specialists were deficient in general philosophy, so far must we guard against being led to avoid generalising on the results of their undoubtedly valuable accumulations of evidence.

The Rev. Hastings Rashdall objected to the retributive theory of punishment, and expected that with the necessary moralization of communities, the sphere of criminal law ought gradually to extend; while Dr. Ferdinand Tönnies, of Kiel University, asserted that all punishment as punishment should cease, though he had no better substitute to offer than a system of fines; while he looked to further research for other means of preventing crime than could be found in the threatened or real consequences of what the criminal had done. Professor Seth, in discussing both these opinions, raised the question whether the newer and older views of punishment were mutually exclusive, and if not, what was their relation to one another, and seemed to favour the idea that punishment must be reformatory only. He asserted "that society was now so securely organised, that it could afford to be not only just, but generous as well." Would not this be rather dangerous pleading if adopted in our Law Courts? Most thinking people would agree with Professor Seth in this adverse criticism of the diverse views advanced by Mr. Rashdall and Dr. Tönnies, and also when he much qualified the idea that crime was a "pathological phenomenon," by urging that "it was only an analogy or metaphor after all, and like all metaphors, might easily prove misleading if taken as a literal description of the facts;" that "to resolve all badness into insanity did not conduce to clear thinking," and that "normal crime, if it had anything to do with insanity, was rather a cause than a result." He said that "To reduce crime to a 'pathological phenomenon' was to sap the very foundation of our moral judgment, merit as well as demerit, reward and punishment, were thereby undermined. Such a view might be scientific, it was not ethical, for it refused to recognise the commonest mora' distinctions." One of the articles of the International Criminological Association, quoted by Dr. Tönnies, said, "Punishment was an act of justice, and the essence of punishment was retribution. From this standpoint, satisfaction was the primary object of punishment, and the other objects included reformation and deterrence." We might justly take this as a fair statement of the facts. While we acknowledged that retribution could only be made in trivial crimes against the property or person, when crimes became more serious, retribution became more or less impossible. Punishment

then must be deterrent, while all punishment should be inflicted with a view to the ultimate reform of the criminal, bearing in mind that in order to secure reformation the conscience of the criminal must be awakened. He must be brought to see that his punishment is just before we could hope for any betterment. In "The Criminal," by Havelock Ellis, one could not fail to be struck with the mass of evidence gathered in the biological and pathological examination of the criminal. But it must be observed that a fair examination of the evidence led to the opinion that the bulk of what were called criminal physiological characteristics were also to be met with in the non-criminal and respectable classes, while many of the so-called criminal characteristics were due to the professional exercise of crime. Lombrosa had been often cited as the greatest living exponent of criminal anthropology, yet he was called rash and unscientific. Ellis spoke of his work as "by no means free from faults. His style was abrupt; he was too impetuous, arriving too quickly at conclusions, lacking in critical faculty and in balance. Thus at an early date he was led to over-estimate the atavistic element in the criminal, and at a later date he has pressed too strongly the epileptic affinities of crime." Yet this was the authority who was often quoted, especially by medical witnesses who advocated irresponsibility of the criminal. Of all his vast mass of investigation, extending to about 30,000 cases, Lombrosa himself had declared that "perhaps not one stone would remain upon another, but that, if this was to be the fate of his work, a better edifice would arise in its place." To illustrate the length to which enthusiastic specialists would go in advocating their own views, Despine, who wrote a good work in 1868, "Psychologie Naturelle," had considered the criminal as "morally mad," and therefore irresponsible, and had said, "No physiologist had yet occupied himself with the insanity of the sane." Was not this evidence of the "illusions of enthusiasm?" We might treat the question of responsibility from an ethical, a metaphysical, a clinical, or a practical point of view, and we must arrive at the conclusion that sane or insane, every criminal must, for the protection of society, be treated as responsible. He had been asked to say something on the treatment of the criminal, but he thought that hardly came within the scope of the

present enquiry. It would be sufficient to say that the trend of modern thought was in the direction of abolishing fixed limits to sentences; that our prisons should be made into Reformatories, where every hour would be profitably occupied, and that when prisoners were reported fit, they should be allowed out on parole. Also, that the surest way to check the increase of the criminal class, is to remove criminal children to a healthy environment.

Mr. RUSDEN remarked that Colonel Goldstein had omitted to mention the system of indeterminate sentences, which he believed to be one which would soon be adopted. Mr. Havelock Ellis mentioned it as having been introduced into America some time ago. To Mr. Frederick Hill belonged the honour of first suggesting this fruitful reform. Lunatics were dealt with on this principle. A lunatic was not liberated until two medical gentlemen certified that the treatment to which he had been subjected had been successful, and that he was fit to be released. At present the law fixed a maximum, and in some cases, a minimum sentence, and the criminal was released very much the worse for his imprisonment after a short definite period, fixed without regard to reason. If the system of indeterminate sentences were given a fair trial, he thought it would be found much more satisfactory than that at present in vogue. He did not believe it was possible to reform a man who had grown accustomed to commit crimes, but with first offenders this system might be very successful.

Mr. ALEXANDER SUTHERLAND said that whilst there was little to cavil at in Colonel Goldstein's paper, there was one point as to which he thought he detected an uncertain sound—viz., with regard to the nature of punishment. Colonel Goldstein had said that punishment might either be retributive, deterrent, or reformatory. If punishment were reformatory, it ceased to be punishment at all. One could not logically speak of reformatory punishment. In that case, it was simply a mode of treating criminals which was reformatory. He agreed with Mr. Rusden that, if a man were allowed to grow up a criminal, he could not be reformed. The leading authorities were agreed on that point. Beyond the age of 10 or 12, the chance of reform was apparently slight. If a man lived up to the age of 20 as a criminal, nothing practically would reform him. Not

only were there good authorities for that statement amongst the leading writers in England, but it could be shown that, even in this colony, such was the fact. Lord John Russell had inaugurated the Penfold scheme—a reformatory scheme in which criminals, when improved to a certain extent, were to be sent to Australia with so much money in their pockets. Two shiploads of criminals, certificated as having been reformed, had been sent to Australia about 1849 or 1850. Two-thirds of the men who had entered the scheme never reached Australia, and those that were sent were the best. These men had not improved the population; but our records of crime showed that, instead of being reformed, when they had got a sum of money in their pockets, and were landed on a new shore to start a new career, they had turned out, as a rule, miserable failures. But it was fair to remember, that the ranks of crime included many characters. There was the criminal who was of an energetic character, and whose energies had been directed into an unfortunate channel. There was the man who had mutinied in the Army, or the man who had merely knocked a hare over which happened to run in front of him. Then again, there was the man whose daughter had been ruined by some wealthy man, and who had avenged himself. These were not criminals in the proper sense of the term. They were on a different footing, and might have a fair chance in a new country, where that very energy and impetuosity that had carried them into a wrong grove in one direction, might make them most successful in another. Many of the world's greatest men would have been great nuisances if they had taken a wrong track; Lord Clive was an instance. Marlborough, too, whose energy would perhaps have been thrown into a wrong channel if his country had not needed his services, had found an outlet for it in slaughtering Frenchmen, and so had become a hero. Passing from the question of reformation, there remained the theories of retribution and deterrence. No philosophical people would hold that punishment should be retributive—that if a man were struck, he should be resolved to return the blow, merely as a matter of retribution, although he would be perfectly entitled to take precaution to prevent a repetition of the act. Retribution was not according to modern views, and there only remained the deterrent view, which should be widened out into a question of placing a sufficiently strong deterrent motive

in the balance of the motives that actuated a man to ensure his actions taking a right direction. There were three great objections to the view that criminals should be eliminated by simply putting them to death:—First, there was the practical one, that the feeling of the race was against it. The second objection was, that the process would have to be repeated time after time. If the least desirable people were singled out at the present moment and got rid of, although the remainder of the population would be improved, but in twenty or thirty years there would be just as much difference between the then respectable classes and the lower classes as there was now, and these would have to be exterminated. In a couple of centuries, people of the character of the judges, who sat upon the bench at the present moment, would be chloroformed as being objectionable people, Then again, was everybody who broke the laws to be chloroformed? At present penalties were awarded on a graded scale, and there were felonies, misdemeanors, &c. The weeding out process would require an arbitrary scale. Would they let off first offenders, or would they draw the line at the second offence? However it was arranged, such violent and arbitrary lines must appear objectionable to the public conscience. The third objection was that nature had arranged the matter in her own way in a far more efficacious style. Although the genus criminal seemed to occur in a sporadic way, it really obeyed certain laws. To make his meaning plain, he would draw their attention to the extensive area from which we inherit our natures. Everybody had two parents, and four grandparents, and eight great grandparents, and so on. In the fourth generation, there were thirty-two ancestors, and in the sixth, sixty-four. In the course of a century and a half, these sixty-four ancestors had each contributed a sixty-fourth part to any one individual's characteristics. Generally, there was a certain accidental blending of all these sixty-four characters, so as to produce a particular result. Take for instance the case of a musician. Out of the sixty-four, there might perhaps have been six or eight who were rather above the average in music. It generally happened there were as many below the average as would balance this, and then the result was an ordinary person who was neither much above nor below the average in musical capacity. But where it happened that a certain number of the sixty-four were rather above the average, and

there were none much below it, and where, added to a musical capacity, there was sufficient industry and inventiveness, the result was a musician. The result of all this theory was that criminals, if not compelled to herd together, would work out their own salvation in generation after generation. If they were compelled to herd together, they invariably died out. A criminal woman very rarely left posterity that would survive two or three generations. With regard to men, too, in following up the history of Australia he had been surprised to observe that there was so little trace of convict blood that had been poured out on these shores so profusely. Australia was not less moral than any similar Anglo-Saxon community. The question was sometimes asked, why we were not deeply tinted with the convict element. There were two classes of convicts. One class who had not inherited the criminal character, but who had been sent out for committing crimes, chiefly by reason of their super-abundant and mis-directed energy, had made excellent settlers, whilst the real criminals had been killed by drinking the plentiful rum of the early settlement days, or being knocked on the head in brawls, and had left no posterity. If nature were left to work in her own way, the matter would come right in the end. The criminal nature would either not perpetuate itself, or the average would be rectified in succeeding generations as the area extended. Therefore, the crude notion of chloroforming the criminal should be disregarded for several reasons. It was not in accordance with the humanitarian views of the present day, and it was founded on a wrong impression of the law of heredity. If criminal were made to pair with criminal, the result would no doubt be a very bad race indeed, supposing they bred. But they would not; and, moreover, they did not and could not be compelled to pair with one another. In conclusion he believed that, at the present time, things should be allowed to remain as they were, and that the pressure of public opinion, and where necessary, of sharp public punishment, would cast sufficient weight on the right side of the motive to induce people to act as best suited the community. Beyond this, there was no need to interefere. We should follow the old lines as much as possible, making our laws as humanitarian as the interests of society would allow.

The PRESIDENT suggested that a definition of criminality and insanity might be desirable.

Mr. WHITE asked Mr. Sutherland upon what statistics he had based his statement that the early convicts were dying out. Not long ago the early criminal records of Tasmania had been sent to Melbourne and destroyed, and shortly afterwards the same had been done with those of New South Wales. He would be much relieved if it could be proved that the criminal class was dying out. but he was unable to take such an optimistic view, and would like to ask Mr. Sutherland the basis of his statement.

Dr. JAMIESON said he hardly thought a definition of either criminality or insanity was practicable. He doubted whether there was any definition of insanity except the bald and unsatisfactory one that it was some departure from the normal mental condition, about which there could be no doubt. As to criminality, he thought there was more difficulty still. The idea of criminality varied indefinitely almost from one generation to another, and in different races. In fact within a very short time it had been made an offence punishable by law to buy or sell a pound of sugar. It was not an offence for a man to sell a cigar or glass of whisky at 8 o'clock at night, but it was an offence to sell a pound of sugar at that hour. The idea seemed to be that criminality was the doing of certain things which the majority had agreed ought not to be done, and the doing of which should be punished. Such an offence was called a crime. It was well known that there were habitual criminals, people who made it their business to commit offences against the law, but it was difficult to get at the root and origin of this tendency. He believed a great many offences were due to intellectual defects. There was a clear enough distinction between a man being weak and being wicked, but it was quite certain that weakness very soon led to wickedness, and a person who was weak in body or mind ran far greater risk of falling into criminality than a person fairly endowed with mental ability and physical power. The man who was mentally weak was liable to be led into crime by stronger minded and less scrupulous persons, and the man who was weak in body was at a disadvantage in earning his living, and fell into such straits that he was tempted to break the law and appropriate that to which he had no right. This habit would grow in both cases, and he did not see why a person without any special criminal tendency might not, if constantly exposed to

temptation, become by force of habit a habitual criminal. This much was clear enough, and capable of proof, but when it came to a question of moral defect, it was difficult to say how far it was natural and how far acquired. It was just as probable that people failed in moral capacity just as they did in intellectual capacity, but it did not necessarily follow that both defects should be co-existent in the same person. A man might be strongly endowed mentally, and yet be weak in moral qualities, and it had been observed that some people who were well endowed morally were rather poor in intellectual constitution. But it was difficult to say how far what was called moral defect was natural, and how far it was acquired. It might be admitted as a likely enough thing that there were people insufficiently endowed with moral qualities, who readily enough became criminals, independently of their intellectual capacity, and as a mere matter of theory it might be admitted that the moral endowment could be so poor that the person of necessity became a criminal. He would not like to say on theoretical grounds that this was not so, but the difficulty was in proving it to be so, and to recognise a theoretical deficiency of moral endowments, apart from pure mental capacity, as a ground of irresponsibilities, was excessively dangerous doctrine. But this seemed to be the doctrine held by the modern school of criminal anthropologists, who went so far as to say that they could tell pretty accurately what would be the physical characteristics of the habitual criminal. He did not think any of them would profess to be able to tell from the physical characteristics of a man, without knowing anything about his conduct, whether or not he was a criminal, and this was the difficulty of safely applying the doctrine, however rational it might be as a general principle, to individual cases. For that reason he thought that any attempts to save criminals from the consequences of their actions on such grounds should certainly not be encouraged, but should on the contrary be discouraged very strongly. With regard to the question of punishment, he agreed with Mr. Sutherland that reformation could not properly be spoken of as a form of punishment, although the criminal might regard in that light any efforts made by the authorities in that direction. He feared that retribution could not be got rid of. If one man inflicted injuries upon another that could be measured pecuniarily, he was fined to a proportionate

extent. Without a doubt there was retribution in that. The man who had not the money to pay was entitled to be punished by having something taken out of him as a *quid pro quo*. He was not prepared to drop the old-fashioned idea of retribution. Of course punishment was also deterrent. It had a deterrent effect upon the offender himself, inasmuch as things were made so unpleasant for him that he would not be likely to repeat the offence. The extreme deterrent was the taking away of life. After all, people value their life more highly than anything else, and death was the strongest possible deterrent the law could inflict. It practically amounted to this, that the community recognised certain crimes as being of such an atrocious character, that it simply decreed that those who committed them should not only be banished from human society, but should have their existence terminated, not only as a strong deterrent, but to prevent the possibility of the act ever being repeated by them. It was not done with any view of exterminating the breed, that was a hopeless task he was afraid. The meeting was greatly indebted to Colonel Goldstein for the manner in which he had brought the matter before it. He was mistaken in thinking that because a man had malformation of the brain, or some disease, that he was therefore insane. He did not think many members of the medical profession would hold such crude doctrines as that. It was quite certain that there might be diseases of the brain without any indication of insanity, and, although it was very unlikely, there might be mental derangement without any demonstrable disease of the brain. As to other matters, he was sure there were not many who would be inclined to differ greatly from what Colonel Goldstein had said.

The Rev. E. H. SUGDEN said that, in a definition of criminality, something was wanted which would connect the selling of an article after hours and the taking of life in cold blood. The anti-social spirit that both acts displayed constituted them crimes against society. It seemed to him that, in order to lessen the criminal population, the artificially made crimes against society ought to be lessened as much as possible. A glance at the list of indictable offences would show that ninety-nine out of every hundred were not wrong in themselves, but were wrong because society had made them wrong. Taking the view that the criminal was an

offender against society, it seemed to him that the proper punishment would be to send him to Coventry, if some reasonable method of doing so could be indicated. If a reasonably fertile and productive part of the earth could be fenced off and made a dumping ground for criminals, where they could be left to develope a State for themselves on their own anti-social lines, it would be a very comfortable thing for Society, and perhaps a very salutary discipline for themselves. This he was afraid was somewhat utopian, but if the social instinct could be aroused in the so-called criminal classes, a great deal of crime would be prevented. If a man could be taught to entertain a real and tender regard for any living thing, a great deal had been done to prevent him from committing crime. In spite of Mr. Sutherland and others, the Christian Church still believed that the criminal could be reformed, if he could only be got to love someone, and that the one Person whom it was easiest and most effectual to bring him to love was our common Master. It seemed to him these were the lines on which the best results would be obtained. The natural punishment for one who manifested the anti-social spirit would be to shut him out of society, and the only remedy would be the promotion of the social spirit in him.

Thursday, July 14th.

The President (Professor KERNOT) occupied the chair.

On the motion of Mr. GRIFFITHS, seconded by Mr. RUSDEN, the minutes of the preceding meeting were taken as read and duly confirmed.

Mr. G. C. W. Officer, Member, and Mr. Strettle, Associate, present for the first time, signed the Roll, and were introduced to the meeting.

Mr. Donald Clarke, of the School of Mines, Bairnsdale, was elected a Country Member.

The PRESIDENT announced that the following gentlemen had been nominated, and would be balloted for at the next meeting:—Rev. Walter Fielder, Associate; L. J. Balfour, Member; Douglas Howard, Associate.

Professor SPENCER, in the absence of the Hon. Librarian, reported that since the last meeting, 92 volumes and

periodicals had been received, and the Council had determined to proceed with the binding of the books belonging to the Library, and 53 volumes had been sent to the binders for that purpose.

The Rev. A. CRESSWELL read a paper entitled "Notes on the Lilydale Limestone," illustrating his remarks by specimens and blackboard drawings.

Mr. GRIFFITHS considered that the geologists of Victoria were under a debt of obligation to the Rev. Mr. Cresswell, for having undertaken the description of this interesting bed of limestone. So far as his recollection went, this was the only bed of crystalline limestone found in Victoria in the Silurian, either upper or lower. The only other deposits of crystalline limestone known to him were some beds in Gippsland, in one of which Mr. Sweet had discovered some very interesting fossil fish. It was to him a source of wonder that the bed described by Mr. Cresswell, lying so near Melbourne, had remained for so many years without any description that was accessible to the public. Mr. Cresswell had been so successful as to obtain a large number of interesting fossils, and no doubt his paper would stimulate geologists generally to pay more attention to the bed of limestone at Lilydale.

Mr. DENNANT regretted very much he never had an opportunity of visiting Lilydale, and was much gratified to see that this matter had been taken up by Mr. Cresswell. He was particularly glad that some palæontological work would embellish the pages of the "Transactions." He did not know whether this bed was definitely known to extend further in the east, but he had heard it said by those who knew the country, that there were outcrops of limestone on the Upper Yarra, about fifteen miles to the north-west of the Emerald Township and Gembrook, but he had never had an opportunity of personally verifying the fact. It would be interesting to know whether this was really an extension of the limestone which outcropped at Lilydale.

Mr. SWEET said he had visited the limestone beds at Lilydale on several occasions, and had taken considerable interest in them. He was therefore very pleased that Mr. Cresswell had taken the matter up, and hoped he would continue his labours until he had given them a complete list of all he had found.

Mr. PRITCHARD said there were some other specimens which he had obtained on a recent visit, and which were very interesting. The first was a coral which Mr. Cresswell had mentioned, namely, Heliolites. A large quantity of this material had been obtained on the last visit, and was in a very perfect state of preservation, so that it would be a good specimen for description. There was another fossil which occurred there rather commonly, but which up to the present had not received any mention at all, although it had been discovered four or five years ago. It was a kind of operculum, which had been handed to Professor McCoy, but had never been described. It seemed to correspond with the *Cyclonema australis*, and he thought it would be well if something were done in connection with the specimens he had mentioned. There were several other specimens of the coral type, some of which were very nteresting, and which he had not been able to identify at all. He would be glad to hand them over to any Member who would undertake a description of them.

Mr. HALL said that Mr. Pritchard had forgotten to mention that one of the specimens of which he had spoken, the operculum of some shell, had been discovered wedged into the mouth of an Euomphalus. Whether it belonged to the Euomphalus or not was a matter which would admit of discussion. They were all obliged to Mr. Cresswell for his interesting paper.

The PRESIDENT said that he had been in the vicinity of the Upper Yarra a good many times, but did not remember noticing any limestone. However, he had not been on a geological expedition, and it was perfectly possible there was plenty of limestone which he had not noticed.

Rev. Mr. CRESSWELL, in reply, said that if any limestone did exist on the Upper Yarra, it was just in position to be a repetition by flexure of the limestone at Lilydale. It was a mistake to suppose there were no other beds of Upper Silurian limestone in Victoria. There were two very extensive thick beds in Gippsland, one at Walhalla, near Cooper's Creek, and another at Deep Creek, about seven or ten miles from Walhalla. They were nearly parallel seams of limestone, and might be a repetition by flexure. The fossils were very similar in both. These beds had been known for a considerable number of years, and were alluded to in the Geological Survey Reports. In conclusion, he

expressed his indebtedness to Mr. Pritchard, who had lent him the fossil which formed the chief matter he had spoken about that evening, and recorded his thanks to Mr. David Mitchell and his foreman, Mr. Fuller, for statistical information.

A "Preliminary Note on the Glacial Deposits of Bacchus Marsh," by Messrs. C. G. W. Officer and L. J. Balfour, was read by Mr. OFFICER.

Mr. DENNANT said that there were a number of questions raised by the paper which he would like an opportunity of speaking upon at considerable length, and as time would not permit of a protracted discussion that evening, he moved "That the discussion on the paper be postponed till the next meeting."

Mr. CRESSWELL seconded the motion for the reasons stated by Mr. Dennant.

The motion was agreed to.

REPORT OF THE CREMATION COMMITTEE.*

The Report of the Cremation Committee was read by the Hon. Secretary, Mr. RUSDEN.

On the motion of Professor SPENCER, seconded by Dr. BRETT, the Report was received.

The PRESIDENT said that a model had been procured which would illustrate the working of the Gorini incinerator, which was the process adopted at Milan, where cremation appeared to be practised to a very considerable extent, and in a way not calculated to offend or disgust in any respect. The Crematory and its surroundings were pleasant and attractive. Milan was one of the largest and busiest cities in the northern parts of Italy, and the Crematory was as near to the centre of Milan as the present Melbourne Cemetery was to the centre of Melbourne.

Mr. F. CHAMBERLAIN produced the model and explained its construction.

Dr. GRESSWELL was heartily in accord with the strong recommendations of the Cremation Committee. He felt that it was a reform that was bound to come, although he was not very sanguine as to its coming quickly. However, he felt satisfied with the progress being made as

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* *Vide supra*, p. 222.

indicated in the Report, and hoped that the Report would encourage those who were interested to make further efforts. With reference to the observations in the Report in regard to Japan, it was an interesting fact that for a very long time past, Cremation had been the rule in Japan, but upon the introduction of European civilisation into Japan fifteen or twenty years ago, it was thought right to follow the European customs in the matter, and substitute burial for Cremation. They soon discovered their error, and reverted to their former practice.

Dr. BRETT moved, "That the Report be adopted by the Society, and printed in its Proceedings." He took considerable interest in the subject of Cremation, and had seen it practised in nearly every country in the world.

Mr. G. A. SYME seconded the motion, which was carried unanimously.

Thursday, August 11th.

The President (Professor KERNOT) occupied the chair.

The minutes of the preceding meeting were read by the Secretary, and duly confirmed.

Dr. Barrett, Member, and Mr. Barnard, Associate, present for the first time, signed the Roll, and were introduced to the meeting.

The PRESIDENT announced that the following gentlemen had been nominated, and would be balloted for at the next meeting:—W. H. Steele, M.A., Associate; Frederick Chamberlain, Member; Alfred Stillwell, Member; and A. Purdy, M.A., Associate.

The following gentlemen were balloted for, and duly elected:—The Rev. Walter Fielder, Associate; Douglas Howard, Esq., Associate; and L. J. Balfour, Esq., Member.

The Librarian's Report stated that 69 publications had been received from various parts of the world, and 44 bound volumes from the binders.

Adjourned discussion on "Preliminary Note on the Glacial Deposits of Bacchus Marsh," by C. G. W. Officer, B.Sc., and L. J. Balfour.

Mr. OFFICER said that since the paper was read he had, together with Mr. Balfour, traversed the whole of the

district covered by the paper, and he wished to make one or two corrections. The first was with regard to the sections described on the Myrniong Creek. It had been stated that the glacial deposit was overlaid by older basalt. This part of the map was outside of that published by the Geological Survey, and he would like to say that this basalt was probably to be referred to the upper and newer basalt, and not the older. In the note, it had also been stated that a certain section was probably an example of contorted till. On further examination, however, this had proved to be not till, but what was called Mesozoic sandstone, and the apparent contortions were due to concretionary action. Also at another section where the glacial deposit was overlaid with sandstone, it had been difficult to decide whether that sandstone was simply associated with till, or belonged to the Mesozoic sandstone in the surrounding district. They were now of opinion that the overlying sandstone was probably of Mesozoic age. On the Korkuperrimul Creek the glacial till was overlaid by basalt, which they thought was to be assigned to the upper basalt. But the evidence on which the distinction between upper and lower basalt was often drawn, seemed to be somewhat feeble.

The Rev. Mr. CRESSWELL said he had a few criticisms to offer upon the paper which Mr. Officer had kindly lent him, and he would begin by recording his appreciation of the value of the paper. It was a most interesting and complete paper, although he was not able to agree with all the conclusions arrived at by the authors. From the evidence adduced by other observers, as for instance Mr. Selwyn, Sir Richard Daintree, Dr. Lendenfeld, and Mr. Dunn, there could be no doubt that in former ages there had existed distinct glaciers in the Alpine districts of Victoria and New South Wales, but it seemed to him to be very questionable whether those glaciers extended any distance from those particular regions. He would begin by making a general criticism upon the terms used. He thought it somewhat misleading to apply the term "till" to two formations which, according to the authors' showing, were so very widely separated in the geological series—one being apparently a Pleistocene glacial deposit of some kind, and the other being a glacial deposit belonging to the Miocene age. He thought it far better to keep the term "till" for well-known and acknowledged

deposits of glacial nature belonging to the Pleistocene age. To apply the term to both formations tended to confusion. He was one of those who believed that till was not a Moraine profonde, but owed its origin to Moraine matter, redistributed partly by aqueous action, and the boulders contained in it were mostly the result of icebergs which had broken away from glaciers and deposited the débris in the clay. Still less was he inclined to believe that these particular formations were instances of a ground Moraine, and he doubted that they necessarily indicated that there had been glaciers on the very spot where they had been found. With regard to the striated pebbles, no one could have the smallest doubt as to their being striated, and having been striated by glacial action. They were evidently striated-glaciated pebbles. He very much doubted, however, that they had been scratched by any rocks where they were now found. So far as his memory served him, the Upper Mesozoic sandstones were particularly soft, and incapable of scratching these pebbles, and he therefore imagined that they must necessarily have come from a very considerable distance—probably from the Alpine regions of either New South Wales or Victoria—and not from the neighbourhood where they were now found. These remarks applied to the upper till, or, as he would call it, the upper glacial formation. With regard to the lower glacial formation, he was not very well acquainted with the nature of the Silurian rocks in the neighbourhood, but unless they contained quartzites very abundantly, he did not know of any rock likely to be capable of imparting the striæ to these pebbles in the Silurian area. He believed that these pebbles, although no doubt glaciated, had been brought from a considerable distance by alluvial and other action. As to the striæ on the Silurian rocks, he would be very sorry indeed to insult their friends' powers of observation, by implying that they could possibly have made a mistake if they had had the opportunity of observing them upon an extended scale; but considering that they had not had such an opportunity, but had only found the striæ here and there in small patches, he would venture to ask them whether they might not have mistaken the unequal wearing of the edges of the rock. He understood from the paper that these grooves were not found in the Mesozoic sandstone, but only in connection with the lower drift on the Silurian rocks, and he was

particularly struck by the remark made in the paper, that these grooves invariably ran north and south, that was to say, exactly coincident with the strike of the strata, and these Silurian strata were tilted up at an angle of 70 degrees. He did not know the extent of the patches uncovered, but considering that the observers were most anxious no doubt to see what they saw, was it not possible that they might have mistaken the unequal wearing of the edges of the Silurian strata. He had frequently seen on the smooth upturned edges of the Silurian strata appearances of very deep grooves, owing to the unequal wearing. But even supposing them to be veritable grooves, it was not beyond the range of possibility that they might have been formed by an iceberg charged with hard pebbles underneath grounding in the neighbourhood on the spot. With regard to the roche moutonnée, he laboured under the disadvantage of never having been on the particular spots which had been mentioned, so that he was unable to judge from his own observation whether they were really instances of roche moutonnée. He would just conceive it possible, therefore, that the hummocky appearance might have been caused by diluvial action. For instance, at Lilydale, there was an appearance of hummocky rock, which was simply caused by the action of the waves on the seashore. Messrs. Officer and Balfour objected to the idea of marine action having anything to do with the phenomena they instanced, but he would venture to point out that there was indisputable evidence that the whole continent had been submerged thousands of feet under the sea. He had seen gravel on the top of Mount Useful covered with basalt, and this was generally put down on the geological maps as marine gravel. There was some doubt as to the age of that particular gravel, but there could be no doubt as to the age of the drifts at Castlemaine and Bendigo, and other places, which would represent a submergence of at least 2000 feet. It was a very moot point as to whether these drifts had been caused by pluvial action, extending over a considerable pluvial period; but he believed, with Selwyn and others, that they were caused by marine action. Although he had appeared to criticise the paper somewhat adversely, he quite admitted it was a very debateable question. Not being an extreme glacialist, he was, perhaps, inclined to minimise the evidence adduced, but he could

quite conceive that others who were extreme glacialists would concede that the authors had fully proved their point.

Mr. GRIFFITHS said that for purposes of discussion the paper might be divided into two parts—the part which was purely descriptive, and the part which offered explanations of the appearances described. The latter part might be divided into three principal propositions which were put forward although not formally stated. The first was that there were evidences locally of two glacial epochs—one early in the Permian, the other early in the Tertiary. The second was that the boulder clay of each of these was due to land ice, and not to marine transport by icebergs. The third was that the submergence of the continent sufficient to float an iceberg at Bacchus Marsh, would reduce the land surface to such a small area that it would be too limited in area to breed icebergs, and too warm to accumulate ice on account of its insularity. With respect to the descriptive part of the paper, he had found many discrepancies between the descriptions given by the authors of the paper and the statements made by the officers of the Geological Survey. The Government officers had given a section showing a thick bed of what had since been termed Triassic conglomerate, which the authors of the paper had attributed to a different period, but did not give a tripartite division, which Messrs. Officer and Balfour stated to exist in the section described on the Werribee River. The Government officers, who were men of experience, had failed to recognise any glaciated rocks in this section, although they had stated that a glacial conglomerate existed in the district. Of course, it sometimes happened that through want of sufficient data, errors had crept into the Geological maps, and he simply pointed this out as showing that it was advisable to carefully weigh the evidence adduced before accepting it. Although the Government geologists had not seen their way to describe the bottom member of this section as a glacial deposit, they had pointed out that the Mesozoic sandstone was composed of two members, the upper being a sandstone and the lower being a conglomerate, and stated that this conglomerate was due to marine action. They recognised a difference, but attributed it to a different cause. With regard to the first proposition, that there

was evidence of two glacial epochs, it certainly did seem upon examination of the specimens and photographs as if there was evidence to show that the bottom member had had a glacial origin. There were undoubted grooves and striæ, and the Silurian rocks were certainly marked as if a plane, with grooves, such as a carpenter would use in his ornamental work, had passed over them. Such was the appearance of rocks which had undergone grinding by the passage over them of a glacier. There was a good deal of weight in Mr. Cresswell's criticism with regard to the rocks having a north and south direction so far as their strike was concerned, and the edges of the Silurian rock being uptilted to a high angle, and varying degrees of hardness and wearing unequally, and all this would have to be taken into consideration before coming to a final conclusion; but, nevertheless, looking at the photographs of the portion of the rock that had been uncovered, it certainly suggested a glacial origin for the rock to his mind. In the second place, the boulders in the till were certainly to a large extent striated, and as suggested, appeared to have been deposited there by ice. There was also another feature which was favourable to the proposition suggested by the authors, namely, the great variety of rock which was found in this clay bed. Such a heterogeneous collection of rocks collected together in one place without any stratification at all, and most of them more or less striated, was certainly to his mind suggestive of glacial action, and pointed to a glacial origin for the deposit. Then again the rocks were not only varied, but they did not correspond with the rocks in the neighbourhood. If the conglomerate was due to coastal action, it would agree with the rocks found in the locality, but that fact, that this was not the case, indicated that the boulders had been brought some considerable distance; and it was well known that a glacier does collect rocks in this manner, and that in a coastal conglomerate no such heterogeneous collection of rocks is found. This was another point in favour of the hypothesis of the authors. It seemed to him that the specimens and descriptions all favoured a glacial origin for this bed, but whether one could go further and agree with the authors of the paper, that the bed was of Permian age, was another matter. In arriving at that conclusion, it was necessary to take a number of matters into consideration. In the first

place, the conglomerate was associated with a bed of rock which was known to be of Mesozoic age. In the second place, there were no Permian rocks described in Victoria, and it was well known that there was a great break in the sequence, the sandstones which were the Upper Devonian rocks being the last rocks met with before reaching the Mesozoic sandstones. There was no such break in the neighbourhood of Sydney, where there was a complete sequence from the Upper Devonian to the Oolite. On the Sydney side the country was sinking and the deposits accumulating, but in Victoria, the other end of the sea-saw, the country was elevated and erosion was going on. Therefore, in Victoria, one did not look for Permian rocks, and if this were a bed of Permian age, it was an interesting fact which required more evidence than was at present available. Its association with the Mesozoic rocks had led the Government geologists to associate it with the beds above it with regard to age, and he did not see any reason for disturbing that conclusion. With regard to the upper glacial deposit, the deposit on top of the Mesozoic sandstone, the rocks in the clay were of the same heterogeneous character, and included granites and porphyries which were striated, and had all the general characteristics of a glacial deposit; but there was one very great difference between the two beds, as had been pointed out by Mr. Cresswell. The lower bed lay upon a surface that had been smoothed and planed apparently by the action of ice, but the upper bed lay upon a sandstone surface as rugged and rough as a mountain peak; and in the fractures which were found in this rugged surface hard clay, very much like a boulder bed, and rocks, including granites, had been jammed down hard, and presented a very different appearance indeed to the bed which lay below it upon the Silurian. If the upper bed were due to glacial origin, certainly the circumstances were very different to those of the lower bed. No heavy mass of ice had ever passed over this till, because if it had, it would have planed all the soft sandstone as smooth as the Silurian had been planed below it. Therefore, if it were due to glacial action, the till and rocks must have been deposited where they were now found by the thin edge of the glacier, an edge which had no weight, but which at the same time was sufficiently strong to carry a burden of rocks and tip them out laterally. This was a possible explanation. It might also have been caused

by a very small glacier indeed from some steep mountain close by, removed by erosion, the glacier itself having no weight or body, but able to bring down stones and tilt them out. This was a very strong point of difference between the two beds of so-called glacial till. Then, with regard to the age assigned to the upper body as being Miocene, he failed to see that there was any evidence at present that would enable them to assign such an early age to the bed. Messrs. Officer and Balfour stated that it was overlaid by a Miocene lava, but he understood them now to retract that statement, and to say they believed that the lava was the recent lava which was found all about the little cavities. Miocene lava was found there, but the Government geologists had not represented it as overlying the Mesozoic sandstones, but stated that it was intrusive and pushed its way through. They represented it as projecting from below, and the Mesozoic sandstone lying upon it. The later lava was distributed all over the country, and lay sometimes on the Silurian, and sometimes on the Mesozoic sandstones, and sometimes upon the conglomerates, which had been described by the authors. Therefore, there was no evidence that he could see, which would justify these gentlemen in attributing to this upper boulder clay the age which they had given to it. Their second proposition was to the effect that the boulders of both these epochs were due to land ice and not to icebergs. With regard to that, the grooves and striæ of the Silurian ran from north to south. As Mr. Cresswell had pointed out, that might be produced by the character of the rock itself; but if there were grooves and striæ there, they were just as one would expect to find them, because the highland there was always found to the north of this point, and ice travelling from the mountain cap must have taken a north and south direction. Had these marks been produced by the grounding of icebergs, one would expect to find something quite different. Icebergs would travel first of all upon the general trend of the coast, which was from west to east. They would travel with the currents of those seas, and as the prevailing winds in this locality were from west to east, so the currents were from west to east, and one would expect to find the icebergs travelling with the currents and with the winds and along the coast line, all three of which ran from west to east. Therefore, if they produced any striæ at all, these striæ would run from west to east. But

it was known that icebergs when they grounded did not produce striæ, in fact could not do so. When an iceberg grounded it swung round on its heel, and if it produced any marks at all on the rock, in the first place it bruised the rocks, and in the second place the rocks which had been embodied in the iceberg and touched the rocky bottom in the bed of the sea, produced marks which were arcs of circles. Icebergs never made straight lines. Then there was another line of argument, which to his mind entirely disposed of the iceberg theory. The Mesozoic sandstone was essentially of fresh or brackish water formation. The only fossils found in the Mesozoic, were two fresh water mollusca and the vegetable remains of ferns. Apart from this, the formation had all the characteristics of sedimentary beds which had been formed in a lake. It was known to most geologists, that the Mesozoic sandstone was a fresh water lake deposit. Our mountains at the time it was formed were very much higher than they are now, and a series of lakes were formed between their shelving sides, and as the lakes got filled up with the sand which now formed the Mesozoic sandstone, the water rose higher. There was very little doubt that it was never anything else than a shallow fresh water lake, perhaps of considerable dimensions. He would like to know how icebergs were going to float in fresh shallow water. An iceberg had one part above water and eight parts below. How were icebergs to float? This was not a marine deposit, and although 2500 feet in thickness, we might depend upon it this Mesozoic sandstone had accumulated gradually, and as it accumulated at the bottom of the lake, the water had risen. No iceberg ever could have floated in these waters, and therefore, in his opinion, no icebergs could ever have caused these marks. There was also another important piece of evidence that should not be disregarded. Around all the remains of all these ancient lakes in Victoria, below the sandstone bed was found a bed of conglomerate. This was apparently the case at Bacchus Marsh, with regard to the conglomerate under discussion. The officers of the Government Geological Survey attributed the bottom member to the action of the water on the coast. Wherever the margin of this sandstone was found, the conglomerate was found under it. On the whole, the evidence was rather favourable to a glacial origin for the bottom deposits at Bacchus Marsh, and he attributed them to land ice, not to icebergs.

With regard to the third proposition, that the immersion of the Continent sufficient to float icebergs would reduce the land surface to such a small area that it would have a mild insular climate. If these beds were due to a deposit in the lakes, they were not due to immersion in the ocean, and the argument of the authors fell through, because they assumed that the high-water level was the high-water level of the ocean, whereas it appeared to him to be the high-water level of various fresh-water lakes.

Mr. DENNANT said he would allude principally to the claim made by these gentlemen for a post-Miocene glacial epoch, or at any rate, even if not post-Miocene, some portion of the Tertiary time, which would include the Eocene, Miocene, and Pliocene. Consequently, if there were glaciers in Victoria at that time, the climate must have been a cold one, for it would be impossible to have a glacier with the temperature the same as at present. If we started with the Eocene, it was well known that there was a very rich fauna in the Eocene, perhaps the richest of any found in any part of the world, but it was essentially a tropical fauna, and no one who had examined the fauna of the Eocene period would doubt for a moment but that he was in the same latitudes as the West Indies and the Tropics generally. Passing from the Eocene to the Miocene, the climate was certainly getting cooler, but was still very much warmer even than our present climate. The shells indicated a climate becoming more and more like the present, but very far indeed from being a glacial one. Passing to the Pliocene, during the last twelve years, two very rich marine deposits had been found in the Pliocene, one in the older Pliocene near Adelaide, and another in the west of our own Colony, at Limestone Creek ; in each of these there was a rich fauna. The climate indicated was slightly colder than that of the Miocene, and in both deposits was found a large number of living shells. In the late Pliocene or almost Pleistocene of Victoria, the living shells amounted to 81 per cent., but they were not those generally found on the present shores of Victoria, or of Southern Australia, but those more frequently found living in the northern parts of the Continent. Consequently, at the time they were deposited the climate was warmer than now, and approximated to the climate of the northern parts of the Continent. It might be concluded that in the older

Tertiary period, there must have been, on the whole, a warm climate, and during that period it would be impossible to expect that any glacial phenomena could have been produced. Besides this, no shells had been found that would indicate Arctic conditions. It was well known that in the glacial till of Europe, Arctic shells were frequently found, and it was possible to trace these deposits by the shells. Where then could the Tertiary glacial epoch of Victoria be placed? Palæontologically, there was no room for it. It might perhaps be mentioned that the sea was certainly close to Bacchus Marsh during Tertiary times. Undoubted evidence of this had been given by Mr. Reginald Murray in one of his reports. A statement had also been made that the pebbles, &c., which had been found, were not known to exist in Victoria. He would like to know what these were, for no list of rocks was given as those not found in any other part of the colony. Then again, amongst these rocks, granite, schist, felspar and sandstone were mentioned, but no mention was made of the Tertiary limestone or any rock of undoubted Tertiary age. If this were a post-Miocene or late Tertiary deposit, he thought we should have some of these rocks amongst those which had been transported.

Mr. JAMES DUNN said that the conglomerate which he regarded as of glacial origin lay at the base of the coal measures. If the conglomerates that he described were the same as those described by the authors of the paper, it was out of the question to speak of roches moutonnées. In fact those who had passed through Bacchus Marsh would have observed the rounded appearance of the hills. This was characteristic of the Mesozoic deposits of every part of the colony, and was certainly due to diluvial action, and he did not think any weight could be laid upon that characteristic feature of the landscape as indicating any glacial action whatever. He was glad the matter had been brought forward, and the authors of the paper had done very good service in making such carful observations, which would enable those who wished to do so to examine the spots referred to for themselves.

Professor SPENCER said that, twelve days since, he had gone with Mr. Dunn to the deposit he had described, for the purpose of being shown what were undoubtedly roches moutonnées. There could not be the slightest doubt about the presence of these at Derinal.

Mr. PRITCHARD said he would like to make a few remarks on the diversity of opinion as to the age of these beds. The Bacchus Marsh beds had been originally set down as Triassic, and the coal measures in Newcastle and in the neighbourhood of Sydney were originally set down as belonging to the Mesozoic period, so that originally the Bacchus Marsh sandstones had been placed on a lower level than the Newcastle coal series. At the present time, the Newcastle coal series were known to belong to the carboniferous age, and the only fossil remains which had been hitherto found in the Bacchus Marsh sanstones were three species of the genus Gangamopteris. The genus itself had been found in the coal measures of New South Wales, in connection with Glossopteris and other genera, which were now looked upon as Mesozoic, and which had always, up to the present time, been looked upon as characteristically Mesozoic, but having been found together with characteristic Palæozoic plants and marine fossils, they were looked upon now as an extension of the range of the genus Glossopteris. This would seem to point to the conclusion that the Bacchus Marsh sandstones might belong to the carboniferous age. Some authorities looked upon the Bacchus Marsh sandstone as belonging to the carboniferous period.

Mr. DENNANT said he only referred to the roches moutonnées in connection with the claim made for Tertiary age. He understood that Mr. James Dunn placed his deposit in the carboniferous era, and evidently referred to a different epoch to that which these gentlemen referred to when they spoke of a post-Miocene glacial epoch. If the fauna did not indicate necessarily the climate, at all events any glacial epoch that might have occurred during Tertiary times must have been of a very spasmodic nature.

Mr. CRESSWELL asked whether the proposition that the upper glacial bed was a post-Miocene deposit had not been withdrawn.

Mr. OFFICER said that in the paper it had been stated that this bed probably belonged to the Tertiary, but they had not attempted to assign it to any particular era in Tertiary times. In fact they had expressly stated that they were unable to find out its relation to the Miocene beds.

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Mr. DENNANT said, that being the case, most of his remarks need not have been made, for he was only claiming

that there was no evidence of a Tertiary glacial epoch in Victoria in that neighbourhood.

Dr. DENDY said there seemed to be one aspect of the question that had not been touched upon, viz., its bearing on the latest glacial theory in Europe and America. He believed, according to this theory, the glacial epoch was attributed to astronomical causes, and it was a remarkable fact that according to this theory, if they had had a glacial epoch in the northern hemisphere, it followed as a natural consequence that there must have been one in the southern hemisphere alternating with it. The European geologists, according to this theory, had confidently predicted that we should find in Australia evidences of a Tertiary glacial epoch. Therefore, he thought it probable that the glacial evidences discovered by Messrs. Balfour and Officer might be Tertiary. With regard to the question of climate in connection with the fauna, the fact that tropical fauna was found in some of these Miocene rocks was rather a strong proof in favour of the glacial theory, because it had been shown that in the glacial epoch in the northern hemisphere there had been a series of unusually warm periods alternating with a series of unusually cold ones. We should therefore expect to find fauna of tropical character in connection with any glacial epoch which might have happened here.

Mr. OFFICER, in reply, said that with regard to the term "Till," he thought it a very good term indeed to apply to any deposit which could be shown to be moraine profonde. As to Mr. Cresswell's contention that till was not ground moraine, but was due to water action, the boulders having been transported by icebergs, that was a theory which would not bear inspection. As to the roches moutonnées, gentlemen did not seem to be quite satisfied as to the genuineness of the article. He had seen many examples of roches moutonnées, but he had seen very few better specimens than those he had described. With regard to the age which they had assigned the lower deposit, they had stated in the paper that it was simply a matter of probability. Their remarks had been based on the fact that in Europe and South Africa, the glacial conglomerates were of Permian age. Mr. Griffiths had stated that in New South Wales there was no break from the Devonian period to the Mesozoic. Professor David had stated that at the close of lower

Carboniferous times there was a distinct break in the flora, and at the close of Permo-carboniferous times there was also a distinct break in the flora. He was inclined to agree with Mr. Pritchard with regard to the Mesozoic sandstones. They had been assigned to Mesozoic age, simply on the evidence of three species of Gangamopteris. Seeing that these occurred associated with Glossopteris in Permo-carboniferous beds in New South Wales, and, as it had been stated by Professor David that Gangamopteris was a more primitive form than Glossopteris, it would almost seem as if these beds were of an earlier age than Mesozoic. Mr. Griffiths had also said he did not think that any ice ever passed over the till at the quarry where the fracture in the sandstone occurred. On his last visit to the same quarry, he had found a similar fracture filled with till-bearing striated stones at a much higher level, and about half-a-mile further up the creek there was a great thickness of this till, exposed at a height between sixty or seventy feet. If that had been accumulated under a glacier, the glacier which could have accumulated it must have extended much further down the valley, and it was probable it did over-ride these stones. The sandstone rock was very soft, and would not show striæ. It had been subjected to much denudation. The rocks also dipped at a considerable angle up to 35 degrees, and a glacier coming down the valley of soft sandstone would be rather likely to fracture them and give them a rugged appearance. On the whole, he did not think anything had been said which would lead them to suppose these deposits were due to anything else than glacier ice.

Mr. STEELE read a paper on "The Conductivity of Copper Sulphate Solutions."

The PRESIDENT said that as it was now past ten o'clock, the other papers would be held over till the next meeting.

Thursday, September 8th.

The President (Professor KERNOT) in the chair.

The minutes of the last meeting were read and confirmed.

Mr. Hogg signed the Roll Book and was introduced to the members.

Mr. Fredrick Chamberlain and Mr. Alfred Stillwell were elected Members, and Mr. A. Purdie, M.A., and Mr. W. H. Steele, M.A., Associates.

The PRESIDENT welcomed to the meeting Professor Haswell, of the University of Sydney, and President of the Linnæan Society of New South Wales.

The Librarian's report showed that 98 new volumes had been added to the Library.

Dr. BARRETT read a paper on "Snake-bite."

In reply to Mr. Ellery, Dr. BARRETT said that snake-bite was usually not a dangerous affection in Victoria. The natural remedy for a severe bite was the expulsion of the poison by downward bandaging. He thought a great deal was to be said in favour of strychnine.

Mr. ELLERY instanced two cases of recovery from snake-bite, but in one case the man was subject to epilepsy ever afterwards. In the other case, injections of ammonia had the effect of causing a cure.

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bite at all. The strychnine treatment for real snake-bite was not at all irrational. The poison could not be extracted once it was absorbed, but the patient could be kept alive by stimulants—alcohol, ammonia, or strychnine. The last was a rational remedy if cautiously used, and if the patient could be kept alive for a sufficient length of time the poison would be thrown off by the kidneys, or might be rendered inert by the action of the liver. The injection of permanganate of potash was to his mind an irrational mode of treatment. It interfered with the circulation, and it could only act on the poison by meeting it on the spot were it existed and destroying it in a chemical way, as any similar substance would be destroyed in the test tube. It was, therefore, haphazardous treatment, as it was uncertain if the permanganate would meet the poison. The time occupied in injecting the permanganate might be utilised to better advantage by excision of the bitten part, or by suction or pressure.

Mr. LUCAS was of opinion that the best thing to do was to keep the patient alive, if possible, by stimulants, until the proteid was oxydised.

Professor HASWELL agreed with Dr. Barrett as to the fallacy of statistics on this subject. He was of opinion that the only light on the matter was to be obtained by means of experiments on animals carefully conducted, with very careful and accurate weighing and measuring of the poison and the antidotes, and the effects of both. He was glad to announce that there was a prospect of some results being obtained from experiments of this nature. Dr. Martin, Demonstrator of Physiology at the Sydney University, was engaged in researches as to the effects of the poison of the Australian snakes.

Mr. FROST had some experience in estimating the time occupied by the poison in circulating through the system. He had caused a tiger snake to bite a rat, and the rat was dead in a minute and a half. It was probable that the poison was injected into the vein. The tiger snake possessed fully three times more poison than any other snake. He had seen a tiger snake emit poison at the third successive bite which would be sufficient to kill a small animal. It was difficult in experiments with small animals to estimate the amount of strychnine necessary to kill

the animal. After injecting strychnine into a rat, the rat recovered from snake-bite, but afterwards it died from the effects of the strychnine.

Dr. BARRETT said that in the *Medical Journal* for 1876 would be found a collection of replies to a circular issued by Dr. McCrae to medical men. He got a return of 253 cases of snake-bite, and 10 per cent. had died without any treatment. It was interesting to note that Australian snakes ejected only a small quantity of poison, while the Indian snake ejected a very large quantity. It was a question whether the doses were in proportion to the size of the animals met with by the snakes. In India of course the animals would be much larger than those met with in Australia. He agreed with the opinion expressed by Professor Haswell, that careful experimenting in the laboratory is the only means of settling the question as to the size of the doses.

Professor SPENCER read some notes on "The Structure of the Poison Fang in certain Australian Snakes."

Professor HASWELL said that he had an opportunity of inspecting Professor Spencer's sections, and there could be no doubt that they proved his deductions.

A paper by Mr. A. J. Campbell, F.L.S., on "Three Rare Species of Eggs," was then taken as read.

Dr. DENDY read a paper on a "Synopsis of the Australian Calcarea Heterocœla, with a proposed Classification of the Group and Descriptions of some New Genera and Species."

An exhibition of specimens followed, and the meeting terminated.

Thursday, October 13th.

Mr. WHITE (Vice-President) in the Chair.

The minutes of the last meeting were read and confirmed.

Dr. DENDY read the Librarian's Report, which showed that 110 new publications had been added to the Library.

A paper by Mr. T. S. Hall, M.A., on "Two New Tertiary Stylasterids," was read by Mr. PRITCHARD.

Mr. PRITCHARD considered that the paper was very interesting, on account of its being the first description of

Stylasterids from Australian Tertiaries. Since looking over Mr. Hall's paper, he had found numerous Stylasterids in his own collection.

Dr. DENDY read notes on "The Method of Reproduction of Geonemertes australiensis."

Mr. E. F. J. LOVE, M.A., exhibited and explained Professor Rowlands' Photographs of the Solar Spectrum.

Thursday, November 10th.

The President (Professor KERNOT) in the Chair.

The minutes of the preceding meeting were read and confirmed.

Professor A. Liversidge, F.R.S., was elected an Honorary Member.

Mr. Steele signed the book, and was introduced to the Members; Mr. Isaac Tipping, C.E., was nominated as an Associate.

The following Members, composing the Antarctic Committee, were re-elected:—The President, and Messrs. Ellery, Rusden, and Griffiths.

The following Members, composing the Port Phillip Biological Committee, were re-elected:—Professor Spencer, Dr. Dendy, Rev. A. W. Cresswell, and Messrs. Bale, Lucas, McGillivray, and Bracebridge Wilson.

The Members composing the House Committee, with Mr. Blackett as Convener, were re-elected.

Mr. LOVE presented and read the Report of the Gravity Survey Committee.* The President and Professors Lyle and Masson, and Messrs. Ellery, White, and Love, were re-elected as Members of Committee.

The PRESIDENT explained that the apparatus which had been used by the Committee, and which was set up in the Observatory, was in perfect order and fit for use.

Mr. W. H. STEELE, M.A., read a paper on "Physical Constants of Thallium."

Mr. LOVE said the paper was a valuable contribution to electrical science. It had brought out an important point,

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* *Vide Suprà*, p. 218.

Tertiary period, there must have been, on the whole, a warm climate, and during that period it would be impossible to expect that any glacial phenomena could have been produced. Besides this, no shells had been found that would indicate Arctic conditions. It was well known that in the glacial till of Europe, Arctic shells were frequently found, and it was possible to trace these deposits by the shells. Where then could the Tertiary glacial epoch of Victoria be placed? Palæontologically, there was no room for it. It might perhaps be mentioned that the sea was certainly close to Bacchus Marsh during Tertiary times. Undoubted evidence of this had been given by Mr. Reginald Murray in one of his reports. A statement had also been made that the pebbles, &c., which had been found, were not known to exist in Victoria. He would like to know what these were, for no list of rocks was given as those not found in any other part of the colony. Then again, amongst these rocks, granite, schist, felspar and sandstone were mentioned, but no mention was made of the Tertiary limestone or any rock of undoubted Tertiary age. If this were a post-Miocene or late Tertiary deposit, he thought we should have some of these rocks amongst those which had been transported.

Mr. JAMES DUNN said that the conglomerate which he regarded as of glacial origin lay at the base of the coal measures. If the conglomerates that he described were the same as those described by the authors of the paper, it was out of the question to speak of roches moutonnées. In fact those who had passed through Bacchus Marsh would have observed the rounded appearance of the hills. This was characteristic of the Mesozoic deposits of every part of the colony, and was certainly due to diluvial action, and he did not think any weight could be laid upon that characteristic feature of the landscape as indicating any glacial action whatever. He was glad the matter had been brought forward, and the authors of the paper had done very good service in making such carful observations, which would enable those who wished to do so to examine the spots referred to for themselves.

Professor SPENCER said that, twelve days since, he had gone with Mr. Dunn to the deposit he had described, for the purpose of being shown what were undoubtedly roches moutonnées. There could not be the slightest doubt about the presence of these at Derinal.

Mr. PRITCHARD said he would like to make a few remarks on the diversity of opinion as to the age of these beds. The Bacchus Marsh beds had been originally set down as Triassic, and the coal measures in Newcastle and in the neighbourhood of Sydney were originally set down as belonging to the Mesozoic period, so that originally the Bacchus Marsh sandstones had been placed on a lower level than the Newcastle coal series. At the present time, the Newcastle coal series were known to belong to the carboniferous age, and the only fossil remains which had been hitherto found in the Bacchus Marsh sanstones were three species of the genus Gangamopteris. The genus itself had been found in the coal measures of New South Wales, in connection with Glossopteris and other genera, which were now looked upon as Mesozoic, and which had always, up to the present time, been looked upon as characteristically Mesozoic, but having been found together with characteristic Palæozoic plants and marine fossils, they were looked upon now as an extension of the range of the genus Glossopteris. This would seem to point to the conclusion that the Bacchus Marsh sandstones might belong to the carboniferous age. Some authorities looked upon the Bacchus Marsh sandstone as belonging to the carboniferous period.

Mr. DENNANT said he only referred to the roches moutonnées in connection with the claim made for Tertiary age. He understood that Mr. James Dunn placed his deposit in the carboniferous era, and evidently referred to a different epoch to that which these gentlemen referred to when they spoke of a post-Miocene glacial epoch. If the fauna did not indicate necessarily the climate, at all events any glacial epoch that might have occurred during Tertiary times must have been of a very spasmodic nature.

Mr. CRESSWELL asked whether the proposition that the upper glacial bed was a post-Miocene deposit had not been withdrawn.

Mr. OFFICER said that in the paper it had been stated that this bed probably belonged to the Tertiary, but they had not attempted to assign it to any particular era in Tertiary times. In fact they had expressly stated that they were unable to find out its relation to the Miocene beds.

Mr. DENNANT said, that being the case, most of his remarks need not have been made, for he was only claiming

that there was no evidence of a Tertiary glacial epoch in Victoria in that neighbourhood.

Dr. DENDY said there seemed to be one aspect of the question that had not been touched upon, viz., its bearing on the latest glacial theory in Europe and America. He believed, according to this theory, the glacial epoch was attributed to astronomical causes, and it was a remarkable fact that according to this theory, if they had had a glacial epoch in the northern hemisphere, it followed as a natural consequence that there must have been one in the southern hemisphere alternating with it. The European geologists, according to this theory, had confidently predicted that we should find in Australia evidences of a Tertiary glacial epoch. Therefore, he thought it probable that the glacial evidences discovered by Messrs. Balfour and Officer might be Tertiary. With regard to the question of climate in connection with the fauna, the fact that tropical fauna was found in some of these Miocene rocks was rather a strong proof in favour of the glacial theory, because it had been shown that in the glacial epoch in the northern hemisphere there had been a series of unusually warm periods alternating with a series of unusually cold ones. We should therefore expect to find fauna of tropical character in connection with any glacial epoch which might have happened here.

Mr. OFFICER, in reply, said that with regard to the term "Till," he thought it a very good term indeed to apply to any deposit which could be shown to be moraine profonde. As to Mr. Cresswell's contention that till was not ground moraine, but was due to water action, the boulders having been transported by icebergs, that was a theory which would not bear inspection. As to the roches moutonnées, gentlemen did not seem to be quite satisfied as to the genuineness of the article. He had seen many examples of roches moutonnées, but he had seen very few better specimens than those he had described. With regard to the age which they had assigned the lower deposit, they had stated in the paper that it was simply a matter of probability. Their remarks had been based on the fact that in Europe and South Africa, the glacial conglomerates were of Permian age. Mr. Griffiths had stated that in New South Wales there was no break from the Devonian period to the Mesozoic. Professor David had stated that at the close of lower

Carboniferous times there was a distinct break in the flora, and at the close of Permo-carboniferous times there was also a distinct break in the flora. He was inclined to agree with Mr. Pritchard with regard to the Mesozoic sandstones. They had been assigned to Mesozoic age, simply on the evidence of three species of Gangamopteris. Seeing that these occurred associated with Glossopteris in Permo-carboniferous beds in New South Wales, and, as it had been stated by Professor David that Gangamopteris was a more primitive form than Glossopteris, it would almost seem as if these beds were of an earlier age than Mesozoic. Mr. Griffiths had also said he did not think that any ice ever passed over the till at the quarry where the fracture in the sandstone occurred. On his last visit to the same quarry, he had found a similar fracture filled with till-bearing striated stones at a much higher level, and about half-a-mile further up the creek there was a great thickness of this till, exposed at a height between sixty or seventy feet. If that had been accumulated under a glacier, the glacier which could have accumulated it must have extended much further down the valley, and it was probable it did over-ride these stones. The sandstone rock was very soft, and would not show striæ. It had been subjected to much denudation. The rocks also dipped at a considerable angle up to 35 degrees, and a glacier coming down the valley of soft sandstone would be rather likely to fracture them and give them a rugged appearance. On the whole, he did not think anything had been said which would lead them to suppose these deposits were due to anything else than glacier ice.

Mr. STEELE read a paper on "The Conductivity of Copper Sulphate Solutions."

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Thursday, September 8th.

The President (Professor KERNOT) in the chair.

The minutes of the last meeting were read and confirmed.

Mr. Hogg signed the Roll Book and was introduced to the members.

Mr. Fredrick Chamberlain and Mr. Alfred Stillwell were elected Members, and Mr. A. Purdie, M.A., and Mr. W. H. Steele, M.A., Associates.

The PRESIDENT welcomed to the meeting Professor Haswell, of the University of Sydney, and President of the Linnæan Society of New South Wales.

The Librarian's report showed that 98 new volumes had been added to the Library.

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first of July shall pay only half of the subscription for the current year. Ordinary Members may compound for all annual subscriptions of the current and future years by paying £21; and Country Members may compound in like manner by paying £10 10s. Any Country Member having compounded for his subscription, and coming to reside within ten miles of Melbourne, must pay either the balance £10 10s. of the Ordinary Member's composition, or one guinea annually while he resides within ten miles of Melbourne. The subscriptions shall be due on the 1st of January in every year. At the commencement of each year there shall be hung up in the Hall of the Society a list of all Members and Associates, upon which the payment of their subscription as made shall be entered. During July, notice shall be sent to all Members and Associates still in arrears. At the end of each year, a list of those who have not paid their subscriptions shall be prepared, to be considered and dealt with by the Council.

Life Membership.

Entrance fees, &c.

XXVI. Newly-elected Ordinary and Country Members shall pay an entrance fee of two guineas, in addition to the subscription for the current year. Honorary Members, Corresponding Members and Associates shall not be required to pay any entrance fee. If the entrance fee and subscription be not paid within one month of the notification of election, a second notice shall be sent, and if payment be not made within one month from the second notice, the election shall be void. Associates, on seeking election as Ordinary or Country Members, shall comply with all the forms prescribed for the election of Members, and shall pay the entrance fee prescribed above of Ordinary or Country Members respectively.

Duration of Meetings.

XXVII. At the Ordinary Meetings of the Society the chair shall be taken punctually at eight o'clock, and no new business shall be taken after ten o'clock.

Order and mode of conducting the business.

XXVIII. At the Ordinary Meetings business shall be transacted in the following order, unless it be specially decided otherwise by the Chairman :—

Minutes of the preceding meeting to be read, amended if incorrect, and confirmed.

New Members and Associates to enroll their names, and be introduced.

Ballot for the election of new Members or Associates.

Vacancies among officers, if any, to be filled up.

Business arising out of the minutes.

Communications from the Council.

Presents to be laid on the table, and acknowledged.

Motions, of which notice has been given, to be considered.

Notice of motion for the next meeting to be given in and read by one of the Secretaries.

Papers to be read.

XXIX. No stranger shall speak at a meeting of the Society unless specially invited to do so by the Chairman. **Strangers.**

XXX. Every paper before being read at any meeting must be submitted to the Council. **Papers to be first laid before Council.**

XXXI. The Council may call additional meetings whenever it may deem it necessary to do so. **Additional Meetings.**

XXXII. Every Member may introduce two visitors to the meetings of the Society by orders signed by himself. **Visitors.**

XXXIII. Members and Associates shall have the privilege of reading before the Society accounts of experiments, observations, and researches conducted by themselves, or original papers, on subjects within the scope of the Society, or descriptions of recent discoveries, or inventions of general scientific interest. No vote of thanks to any Member or Associate for his paper shall be proposed. **Members may read papers.**

XXXIV. If a Member or Associate be unable to attend for the purpose of reading his paper, he may delegate to any Member of the Society the reading thereof, and his right of reply. **Or depute other Members.**

XXXV. Any Member or Associate desirous of reading a paper, shall give in writing to one of the **Members must give notice of their papers.**

Secretaries, ten days before the meeting at which he desires it to be read, its title and the time its reading will occupy.

Papers by Strangers.

XXXVI. The Council may for any special reason permit a paper such as is described in Law XXXIII, not written by a member of the Society, to be read by one of the Secretaries or other Members.

Papers belong to the Society.

XXXVII. Every paper read before the Society shall be the property thereof, and immediately after it has been read shall be delivered to one of the Secretaries, and shall remain in his custody.

Papers must be original.

XXXVIII. No paper shall be read before the Society or published in the Transactions unless approved by the Council, and unless it consist mainly of original matter as regards the facts or the theories enunciated.

Council may refer papers to Members.

XXXIX. The Council may refer any paper to any Member or Members of the Society, to report upon the desirability of printing it.

Rejected papers to be returned

XL. Should the Council decide not to publish a paper, it shall be at once returned to the author.

Members may have copies of their papers.

XLI. The author of any paper which the Council has decided to publish in the Transactions may have fifty copies of his paper on giving notice of his wish in writing to one of the Secretaries, and any further number on paying the extra cost thereof.

Members and Associates to have Transactions.

XLII. Every Member and Associate whose subscription is not in arrear, and every Honorary and Corresponding Member is entitled to receive one copy of the Transactions of the Society as published. Newly-elected Members shall, on payment of their entrance-fee and subscription, receive a copy of the volume of the Transactions last published.

Property.

XLIII. Every book, pamphlet, model, plan, drawing, specimen, preparation, or collection presented to or purchased by the Society, shall be kept in the house of the Society.

Library.

XLIV. The Library shall be open to Members and Associates of the Society, and the public, at such times and under such regulations as the Council may deem fit.

XLV. The legal ownership of the property of the Society is vested in the President, the Vice-Presidents, and the Treasurer for the time being, in trust for the use of the Society; but the Council shall have full control over the expenditure of the funds and management of the property of the Society. Legal ownership of property.

XLVI. Every Committee appointed by the Society shall at its first meeting elect a Chairman, who shall subsequently convene the Committee and bring up its report. He shall also obtain from the Treasurer such grants as may have been voted for the purposes of the Committee. Committees elect Chairman.

XLVII. All Committees and individuals to whom any work has been assigned by the Society shall present to the Council, not later than the 1st of November in each year, a report of the progress which has been made; and, in cases where grants of money for scientific purposes have been entrusted to them, a statement of the sums which have been expended, and the balance of each grant which remains unexpended. Every Committee shall cease to exist at the November meeting, unless then re-appointed. Report before November 1st.

XLVIII. Grants of pecuniary aid for scientific purposes from the funds of the Society shall expire on the 1st of March next following, unless it shall appear by a report that the recommendations on which they were granted have been acted on, or a continuation of them be ordered by the Council. Grants expire.

XLIX. In grants of money to Committees and individuals, the Society shall not pay any personal expenses which may be incurred by the Members. Personal expenses not to be paid.

L. No new law, or alteration or repeal of an existing law, shall be made except at the Annual General Meeting in March, or at a Special General Meeting summoned for the purpose, as provided in Law XIX, and in pursuance of notice given at the preceding Ordinary Meeting of the Society. Alterations of laws.

LI. Should any circumstance arise not provided for in these Laws, the Council is empowered to act as may seem to be best for the interests of the Society. Cases not provided for.

Corresponding Members.

LII. The Council shall have power to propose gentlemen not resident in Victoria, for election in the same manner as Ordinary Members, as Corresponding Members of the Society. The Corresponding Members shall contribute to the Society papers which may be received as those of Ordinary Members, and shall in return be entitled to receive copies of the Society's publications.

Privileges of Associates.

LIII. Associates shall have the privileges of Members in respect to the Society's publications, in joining the Sections, and at the Ordinary Meetings, with the exception, that they shall not have the power of voting; they shall also not be eligible as Officers of the Society.

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OF

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Biological Society of Liverpool	Liverpool
Bodleian Library	Oxford
British Museum	London
Colonial Office Library	London
"Electrician"	London
Foreign Office Library	London
Geological Society	London
Institute of Mining and Mechanical Engineers	Newcastle
Institution of Civil Engineers	London
Linnæan Society	London
Literary and Philosophical Society ...	Liverpool
Marine Biological Laboratory	Plymouth
Natural History Museum	London
Naturalists' Society	Bristol
"Nature"	London
Owens College Library	Manchester
Patent Office, 25 Southampton Buildings	London
Philosophical Society	Cambridge
Royal Asiatic Society	London
Royal Astronomical Society	London
Royal Colonial Institute	London
Royal Gardens	Kew
Royal Geographical Society	London
Royal Microscopical Society	London
Royal Society	London
Statistical Society	London
University Library	Cambridge

Scotland.

Botanical Society	Edinburgh
Geological Society	Edinburgh
Royal College of Physicians' Laboratory ...	Edinburgh

Royal Observatory	Edinburgh
Royal Physical Society	Edinburgh
Royal Society	Edinburgh
Royal Scottish Society of Arts	Edinburgh
Scottish Geographical Society	Edinburgh
University Library	Edinburgh
University Library	Glasgow

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Royal Dublin Society	Dublin
Royal Geological Society	Dublin
Royal Irish Academy	Dublin
Trinity College Library	Dublin

GERMANY.

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Grossh. Hessische Geologische Anstalt ...	Darmstadt
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ART. I.—*Notes on the Eocene Strata of the Bellarine Peninsula with brief references to other deposits.*

(With Plate I.)

By T. S. HALL, M.A., and G. B. PRITCHARD.

[Read 9th March, 1893].

Our chief inducement for visiting the Bellarine Peninsula was the object of settling on palæontological evidence whether the small outcrop marked on the maps (¼ sheet 23 S.W.) belongs to eocene or to miocene age, the two sets of beds having been elsewhere confused. Certain peculiarities of the deposits however induced us to extend our observations to other portions of the district where similar beds are exposed.

The Peninsula consists of a central mass of the Jurassic freshwater series, an outlying portion of the Barrabool and Otway beds. Overlying these beds in their northern area occurs the Older Basalt, affording by its decomposition the rich soil for which that part of the district is so well known. Surrounding this central mass is a ring of marine eocene beds. Exposures of the latter occur on the northern and southern boundaries wherever the natural conditions afford an opportunity of seeing them. On the eastern and western sides no exposures are to be seen as the thick mantle of upper tertiary beds covers the slopes and flats and hides the underlying series from view. There is little doubt however that the ring is complete, as to the westward the Geelong eocenes, as represented by the Corio Bay, Moorabool Valley and Belmont beds are well developed, while to the eastward the Mornington beds occur just across the bay, and as Mr. Daintree reports* similiar beds were passed through in the Queenscliff bore.

The jurassic rocks, although occuping such a large extent of the peninsula, show only one small outcrop just to the westward of Portarlington.† A syncline occurs between the Bellarine beds

* Parl. Rep., 1861-62, A 43. † ¼ Sheet 23 N.E. Note.

and those of the Barrabools, the latter dipping easterly and showing in a series of outcrops the beds proved in the Bellarine bores.*

THE OLDER VOLCANIC.

Along the cliffs at Portarlington the older volcanic rock occurs on both sides of the pier and exhibits various degrees of decomposition. In one place it is quarried for road metal, while to the east it is a soft unctuous clay which can be traced along the cliffs gradually showing more and more its true character till it disappears below sea level. In this locality it is overlain by coarse ferruginous grits which are probably of upper tertiary age. Near the Clifton Springs it forms the greater part of the cliffs. Here, at about thirty feet above sea level, it is covered by a conglomerate consisting of sub-angular and well rounded pebbles up to four or five inches in diameter, and comprising quartz in various forms, hard blue metamorphic sandstones, nodular schists, and other altered argillaceous rocks with beds of sand and clay. Towards the top it gradually becomes finer and more sandy. At the Drysdale Pier hard ferruginous grits come down to the water's edge, the volcanic rock having been here, as elsewhere, deeply denuded. At the next point, about a quarter of a mile west of the pier, the beach floor and cliffs consist of a volcanic ash or breccia, full of angular fragments of scoriaceous basalt up to an inch in diameter. The deposit is well and evenly bedded and has a dip some degrees west of north at about 20°. Decomposition has considerably affected the strata and the colours are very variable, being blue, gray, dark-green, fawn and chocolate. From here, for about 2½ miles westward, these ash beds are almost continuously exposed to view on the beach floor with intermissions to be mentioned presently. In some places the cliffs are seen to be almost entirely composed of ash overlain by a variable thickness of upper tertiary clays and grits. The ash beds gradually sink to sea level and disappear near the boundary between the parishes of Bellarine and Moolap, where they are overlain by eocene beds. These continue for nearly half a mile, when ash beds again appear from beneath them with a north-easterly dip. We roughly estimated a thickness of 300 feet of

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* ¼ Sheet 24 S.E. Note 7.

ash to be exposed here. At the place marked Ad 12 on the ¼ Sheet, which is the most prominent point between Clifton and Point Henry, a dyke of fine, dense basalt occurs in the ash. The included fragments in the ash beds here are of larger size, some being upwards of two feet in diameter, and consist principally of masses of basalt, though a few embedded blocks of brownish sandstone, and of an altered yellow argillaceous rock were visible. The latter are probably derived from the underlying mesozoic rocks, though considerably altered in appearance and hardness, they at any rate do not resemble any of our Silurian rocks. From the size of the ejected masses, and from the presence of the dyke, it is probable that we are here close to a vent of the Older Volcanic rock, the greater part of the core having been removed by denudation. Overlying the ash at this point and on its eroded surface occurs a sheet of polyzoal rock. That it does not consist of ejected fragments is clear from its well bedded structure and from its constant dip. It occurs in large tabular masses and is nowhere seen overlain by the volcanic rock. It has for the most part been removed on the higher parts of the beach, where loose blocks of it occur; but at low-tide it may be seen to form a fairly continuous sheet passing out under water to the north. In most places it is altered to a crystalline reddish rock, the weathered surfaces of which are crowded with fossils standing up in relief, and the usual cream colour, which characterises the rock in other localities, prevails. The fossils are principally polyzoa though brachiopods, lamellibranchs and gastropods occur. Similar rock occurs at Sutherland's Creek, near Maude, and again in the Moorabool Valley,* and is at the latter place not associated with igneous rock. At the parish boundary, (Locality 1) where we first noted the eocene beds, the dip of the ash beds and of the former is approximately to the north-west and the volcanic series can be seen passing beneath the fossiliferous strata. So that in these two places we have evidence, that here, the older volcanic rocks are antecedent to the eocene series, and not overlying them as indicated in Daintree's report on the district† and by the colouring and lettering on ¼ sheets 23 S.E. and 23 S.W.

* Proc. Roy. Soc. Vic., vol. iv., N.S., p. 11. † Parl. Report, 1861-62, A 43.

In the ¼ sheets (23 S.W. and 23 S.E.) dealing with this portion of the district, some confusion exists as to the volcanic rocks. The large outcrop forming the Bellarine Hills is marked as older volcanic, of which it is regarded as forming a typical locality. On the west side of the road from Portarlington to Drysdale, the lettering in the two places indicates newer pliocene overlying older volcanic in one case close to the cliff, while the cliff section shows an outcrop coloured to represent lower volcanic ('pliocene'), but not lettered. On ¼ sheet 23 S.W. the same outcrop is shown running along past Clifton Springs, with one intermission, to a short distance past the dyke we have alluded to. This intermission should not occur, as the ash beds crop out continuously along the beach at this place. Both these separated portions of the same outcrop are marked V. 1, 2, 3, that is, as the legend shows, lower volcanic ('pliocene') basalt dolerite, anamesite and lava, while V. 4 (ash, conglomerate, &c.) is omitted, although a section of over two miles in length is exposed. This is not all, for a note near the parish boundary and close to the volcanic outcrop states that "the basalt outcrop of the Bellarine Hills probably underlies the pliocene tertiary sands and ironstones as far south as the heads of the creeks falling into Corio Bay." So that this outcrop is coloured 'pliocene' and alluded to as 'miocene;' while the true state of the case is that it is unconformably overlain by the clays which were then called miocene or oligocene but which are now regarded as eocene.

The Curlewis Eocenes.

This will be a convenient name for this section, as the hamlet of Curlewis is situated on the Portarlington Road, about a mile to the southward.

It is probable, as will presently appear, that the sequence of eocene beds here is similar to what occurs in the Moorabool Valley,* that is, that the polyzoal rock, where it occurs, is the underlying member of the series, though we were unable to absolutely prove the succession.

At the first place where we noted the eocene beds (parish boundary), they consisted of blue clays resting on ash beds, the

* Proc. Roy. Soc. Vic., vol. iv., N.S., pp. 9 et seq.

dip of both deposits being to the seaward. This dip is the most marked peculiarity of the beds in this locality. There occurs a band of about six feet in thickness of marked character which can be traced, with but few intermissions, for two miles along the coast. Its upper portion consists of about three feet of dark-brown earthy limestone, very sandy, and containing casts of fossils; below this, is about 18 inches of gray clay and then about the same thickness of a rock similar to the upper band, but more easily weathered and of a lighter hue. Both above and below this band, occur stiff blue clays similar to those of Mornington, Spring Creek and the Gellibrand. The angle of dip averages about 25°. In some places it is as low as 10° and near the western end of the section for about 30 yards it dips at 45°. Dipping as the beds do, this hard band stands out from the softer clays like a wall, usually from two to three feet above the almost level floor of the beach. The beds as shown by this band are contorted and faulted. At the parish boundary, we can on ascending the low cliff, see the band coming in to the shore from the north-east and winding with a serpentine curvature. It sweeps round the point in one curve, the dip swinging through an arc of 90°, from a few degrees east of north to a few degrees north of west. Numerous small faults occur, trending north-west, the throw being usually a few inches and rarely exceeding a foot, and the hade nearly vertical. In one place we counted six faults in about 50 yards Along this outcrop the easterly beds are shifted to the north, or in other words, the downthrow is to the south-west. We thus have displayed a beautiful series of step faults. In one place on the curve however, the band between two faults has gone out into deep water, and although the tide was low we could not find any trace of the band *in situ*. Actual measurement showed a lateral displacement of over 30 feet while the loose blocks in the water, which stopped further measurement, showed the direction in which displacement had taken place.

The clay above and below the band is full of nodules of iron pyrites. In places slight hollows on the beach are full of loose pieces washed out, and covered with a crust of limonite. Occasionally, below the band the pyrites has oxidized *in situ*, and has stained the clay yellow. This decomposition is however more frequent in the clay overlying the band and the general tint is consequently of a lighter hue.

Blocks of the earthy limestone band occur on the beach at this point, above high-water mark, and lithologically closely resemble eocene rocks forming the cliffs on the western shores of Corio Bay. From these blocks we procured the following fossils:

Dimya dissimilis, Tate.
Pecten Yahlensis, T. Woods.
Spondylus pseudoradula, McCoy.
Waldheimia divaricata, Tate.
Polyzoa.
Echini spines.

The clays of this place (Locality 1) however, yielded a far greater number of forms, as shown by the following list, which is the result of but a few hours work.

LIST OF FOSSILS FROM LOCALITY 1.

Class, Zoantharia.
Placotrochus deltoideus, Duncan.
Flabellum Victoriæ, Duncan.
Conosmilia anomala, Duncan.

Class, Echinodermata.
Cidaroid spines.

Class, Polyzoa.
Numerous genera and species.

Class, Palliobranchiata.
Terebratulina Scoulari, Tate.

Class, Lamellibranchiata.
Pecten dichotomalis, Tate.
„ Foulcheri, T. Woods.
„ (Amussium) Zitteli, Hutton.
Lima Bassii, T. Woods.
Limea transenna, Tate.
Modiolaria singularis, Tate.
Crenella n. sp. aff. globularis.
Nucula tumida, T. Woods.
„ Atkinsoni, Johnston.
Leda Huttoni, T. Woods.
„ apiculata, Tate.
„ obolella, Tate.

Pectunculus laticostatus, Quoy and Gaimard.
Macrodon Cainozoicus, Tate.
Cucullæa Corioensis, McCoy.
Cardita sp.
Chama lamellifera, T. Woods.
Chione? n. sp.
Myadora tenuilirata, Tate.

Class, Gastropoda.

Ranella Prattii, T. Woods.
Triton tortirostris, Tate.
Fusus craspedotus, Tate.
Peristernia lintea, Tate.
,, sp.
Zemira præcursoria, Tate.
Voluta antiscalaris, McCoy.
,, McCoyii, T. Woods.
,, n. sp. = Spring Creek.
,, (Volutoconus) n. sp. aff. conoidea.
Lyria harpularia, Tate.
Mitra atractoides, Tate.
Marginella propinqua, Tate.
,, sub-Wentworthi, Tate.
,, micula, Tate.
,, sp.
Ancillaria hebera, Hutton.
,, pseudaustralis, Tate.
Columbella clathrata, Tate, m.s.
,, sp.
Cancellaria Etheridgei, Johnston.
,, n. sp.
Pleurotoma sp.
Drillia sp.
Mangilia sp.
? ,, sp.
Raphitoma n. sp.
Pusianella aff. hemiothone.
,, n. sp.
Conus heterospira, Tate.
Cypræa brachypyga, Tate.

Semicassis transenna, Tate.
Cassidaria gradata, Tate.
Natica Hamiltonensis, T. Woods.
Crepidula sp.
? Scalaria sp.
Turritella Murrayana, Tate.
,, sp.
,, sp.
Vermetus sp.
Niso psila, T. Woods.
Cerithiopsis n. sp.
Delphinula aster, T. Woods.
Scaphander fragilis, Tate, m.s.
Ringicula sp.
Cylichna exigua, T. Woods.

Class, Scaphopoda.
Entalis Mantelli, Zittel.
,, subfissura, Tate.

Class, Pisces.
Otoliths.

SUMMARY FOR LOCALITY 1.

Class.	No. of Species.
Zoantharia - - - - -	3
Palliobranchiata - - -	1
Lamellibranchiata - - -	19
Gastropoda - - - - -	46
Scaphopoda - - - - -	2
Pisces - - - - - -	1
Total - - - -	72

At the point where the polyzoal rock occurs, and on the west side of the gully two intersecting faults, trending N.E. and N., are distinctly traceable on the beach, as they have lowered the eocene blue clay into the ash beds. Each of these faults is visible for several yards, as the clay, being softer than the volcanic rock at this point, has been removed by the waves to about a foot below

the level of the latter. A third fault, completing the triangle and having the N.W. trend of all the other faults observed, probably occurs to the westward, but was not visible. The position of the clay beds here, lends force to the view already stated that the polyzoal rock underlies the clay, as close at hand the limestone is seen *in situ* in contact with the volcanic rock; while the downthrow of a fault has been necessary to bring the clay to its level.

About two hundred yards west of this point (Locality 2 on plan) we again find the band, described above, making its appearance, and being traceable for nearly half-a-mile along the shore before disappearing beneath the upper tertiary beds to the west. At the former place where we described it, it has a northerly dip and the lowest beds are on the landward side. Here however, the dip is reversed and the lower beds are to the seaward, a syncline running N.E. and S.W. The strata can be fairly termed contorted. A system of faults with a north-westerly trend is again developed, with the same average throw. Our time did not allow us to work out the directions of the downthrow, the matter being complicated by the contortion of the strata.

To show the way in which contortion has taken place a few examples may be given. At one place the band dips W.—S.—E. at 10°, the radius of curvature of the outcrop being about 20 feet and the upper beds being inside the curve. Then the western end of the band curves round, dipping S.E.—S.—S.W. at 25°, the radius of curvature being 30 feet and the upper beds being on the outside of the curve. The band is curved three or four times in a similar manner to the westward of this point within a distance of a few hundred yards, and it is at this end of the section that we noted the dip as 45° for 30 feet of strike.

Although the beds are so much disturbed the number of crushed shells does not seem greater than usual. Even close to the faults, large shells were perfect. Some specimens which were in contact with pyrites nodules were crushed, but for the most part the fossils were beautifully preserved. From the earthy limestone band of this locality (2) we gathered the following forms:—

Waldheimia divaricata, Tate.
„ insolita, Tate.

Dimya dissimilis, Tate.
Pecten Foulcheri, T. Woods.
Chione Cainozoica (?), T. Woods.
Leda sp. (cast).
Pectunculus laticostatus, Quoy and Gaimard.
Cypraea leptorhyncha, McCoy.

As before, however, the clay beds were the most prolific in fossils, and we give a list of the species gathered, together with references showing their occurrence in some other localities. In this table, the forms gathered at Locality 1 but which were not obtained at Locality 2 are marked with the sign †.

Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
Class, Rhizopoda.				
Order, Foraminifera.				
Biloculina sp. - - - - -	-	X	-	X
? Miliolina sp. - - - - -	-	X	X	X
? Orbitolites sp. - - - - -	-	-	-	X
Other genera and species - -	-	X	X	X
Class, Actinozoa.				
Order, Zoantharia.				
Flabellum Victoriæ, Duncan -	X	X	X	X
Placotrochus deltoideus, Duncan -	X	X	X	X
Conosmilia anomala, Duncan - -	X	X	X	X
Class, Echinodermata.				
Lovenia Forbesi, Duncan - -	-	-	X	-
† Cidaroid spines - - -	X	X	-	X
Class, Polyzoa.				
Numerous genera and species -	-	X	X	X
Class, Palliobranchiata.				
Waldheimia divaricata, Tate - -	-	-	-	-
† Terebratulina Scoulari, Tate - -	-	X	X	X
Class, Lamellibranchiata.				
Ostræa ? n.sp.	-	-	-	-
Dimya dissimilis, Tate - -	X	X	X	X
Pecten dichotomalis, Tate - -	-	X	-	-
„ Yahlensis, T. Woods - -	-	X	X	X
„ Foulcheri, T. Woods - -	X	X	X	X
† „ (Amussium) Zitteli, Hutton -	X	X	X	X
Lima Bassii, T. Woods - -	X	X	-	X
† Limea transenna, Tate - -	-	X	-	X

Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
Spondylus pseudoradula, McCoy	-	X	-	X
Septifer fenestratus, Tate	X	X	-	X
† Modiolaria singularis, Tate	-	X	-	X
† Crenella n.sp. aff. globularis	-	-	-	-
Nucula tumida, T. Woods	-	X	X	X
„ Atkinsoni, Johnston	-	X	-	X
„ Morundiana, Tate	X	-	X	X
† Leda obolella, Tate	-	X	-	X
„ Huttoni, T. Woods	X	X	X	X
„ apiculata, Tate	X	X	? X	X
„ praelonga, Tate	-	X	-	X
Limopsis Belcheri, Adams and Reeve	X	X	X	X
Pectunculus laticostatus, Quoy and Gaimard	X	X	X	X
Macrodon Cainozoicus, Tate	X	X	X	X
Cucullæa Corioensis, McCoy	X	X	X	X
Crassatella astartiformis, Tate	X	X	X	X
Cardita polynema, Tate	? X	X	X	-
„ delicatula, Tate	X	X	X	X
Chama lamellifera, T. Woods	X	X	X	X
Chione Cainozoica ? T. Woods	-	X	X	X
† „ ? n.sp.	-	-	-	-
† Myadora tenuilirata, Tate	-	X	X	X
„ n.sp.	-	-	-	-
Corbula ephamilla, Tate	X	X	X	X
„ pixidata, Tate	X	X	X	-
Class, Gastropoda.				
Murex velificus, Tate	X	X	X	X
„ rhysus, Tate	-	X	-	X
„ Dennanti, Tate	-	-	-	X
„ Eyrei, T. Woods	X	X	X	X
„ n.sp.	-	-	-	-
Typhis acanthopterus, Tate	X	X	-	-
Rapana aculeata, Tate	X	X	? X	X
Ranella Prattii, T. Woods	X	X	-	X
Triton cyphus, Tate	-	X	-	X
„ Woodsii, Tate	X	X	X	X
„ tortirostris, Tate	X	X	X	X
„ gemmulatus, Tate	X	X	-	X
Fusus acanthostephes, Tate	X	X	X	X
„ craspedotus, Tate	X	X	-	X
„ dictyotis, Tate	-	X	-	X
„ n.sp.	X	-	-	-
„ n.sp.	-	X	-	-
Latirofusus aciformis, Tate	-	X	-	X
Siphonalia longirostris, Tate	X	X	-	X
„ n.sp. aff. longirostris	-	-	-	-
Fasciolaria decipiens, Tate	X	-	-	X
Peristernia Morundiana, Tate	-	-	-	-
„ lintea, Tate	-	-	-	X

Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
Peristernia n.sp.	-	-	-	-
„ n.sp. aff. crassilabrum	? X	-	-	-
Dennantia Ino, T. Woods	X	X	-	X
Zemira præcursoria, Tate	-	-	-	X
Phos, n.sp.	-	-	X ?	-
Voluta Hannafordi, McCoy (frag.)	-	X	-	X
„ ancilloides, Tate	-	X	X	X
„ McCoyii, T. Woods	? X	X	-	X
„ cathedralis ? Tate	-	-	-	X
„ antiscalaris, McCoy	X	X	-	X
„ strophodon, McCoy	X	X	-	X
„ n.sp. 1. aff. lirata	? juv.	-	-	-
„ n.sp. 2.	? juv.	-	X	-
„ n.sp. 3. aff. n.sp. Muddy Creek	-	-	-	-
† „ n.sp. 4. aff. conoidea	-	-	-	-
Lyria harpularia, Tate	X	X	-	X
Mitra alokiza, T. Woods	X	X	-	X
„ othone, T. Woods	X	X	-	X
„ atractoides, Tate	X	-	-	X
„ n.sp. aff. leptalea	-	-	-	-
Marginella Woodsii, Tate	-	-	-	X
„ propinqua, Tate	X	X	X	X
„ micula, Tate	X	X	X	X
„ Wentworthi, Tate	X	X	X	X
„ sub-Wentworthi, Tate	X ? frag.	X	-	-
† „ sp.	X	X	X	X
Ancillaria hebera, Hutton	-	-	X	X
„ semilævis, Tate	X	X	-	X
„ pseudaustralis, Tate	-	X	-	X
Columbella clathrata, Tate m.s.	X	X	-	X
† „ sp.	? X	X	-	-
„ sp. aff. clathrata	? X	-	-	-
Cancellaria Etheridgei, Johnston	X	-	X	-
„ caperata, Tate	X	X	-	-
† „ n.sp.	X	-	-	-
Pleurotoma paracantha, T. Woods	X	X	X	X
„ Claræ, T. Woods	X	X	-	X
„ sp.	X	X	X	X
„ sp.	-	-	X	-
Drillia, sp.	? X	? X	-	X
Mangilia bidens, T. Woods	X	X	-	X
„ sp.	-	-	-	X
† ? „ sp.	-	-	-	-
Bela sculptilis, ? Tate	-	-	X	X
„ sp. aff. sculptilis	-	-	-	-
Raphitoma n.sp.	-	-	-	-
Pusianella sp. aff. hemiothone	-	-	-	-
„ n.sp.	-	-	-	-
Daphnella tenuisculpta, T. Woods	-	X	-	X
Conus heterospira, Tate	X	X	-	X

Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
Conus Dennanti, Tate	-	X	X	X
„ n.sp. aff. heterospira	-	-	-	-
Cypræa contusa, McCoy	-	X	-	X
„ pyrulata (?), Tate	-	X	-	X
„ brachypyga, Tate	X	X	-	X
„ leptorhyncha, McCoy	-	X	X	X
„ Mulderi, Tate	X	-	-	-
Trivia avellanoides, McCoy	X	X	X	X
† Semicassis transenna, Tate	-	X	-	X
Cassidaria gradata, Tate	-	X	-	X
Natica Hamiltonensis, T. Woods	X	X	-	X
„ polita, T. Woods	X	X	-	X
Crepidula sp.	-	X	-	-
† ? Scalaria sp.	-	-	-	-
Turritella Murrayana, Tate	X	X	-	X
„ sp.	X	X	X	X
„ sp.	X	X	-	X
„ sp.	X	-	X	-
Siliquaria squamulifera, Tate m.s.	X	X	-	X
Vermetus conohelix, T. Woods	X	X	X	X
„ sp.	X	X	-	-
Eulima sp.	? X	-	-	-
Niso psila, T. Woods	X	X	-	X
Odostomia sp.	X	-	-	-
„ sp.	X	-	-	-
Cerithium crebarioides, T. Woods	X	X	X	X
„ n.sp. aff. crebarioides	-	-	-	-
† Cerithiopsis n.sp.	X	-	-	-
„ n. sp.	-	-	-	-
Triforis Wilkinsoni, T. Woods	X	X	-	X
„ sp.	-	X	-	X
? Calliostoma sp.	-	-	-	? X
Delphinula aster, T. Woods	X	X	-	X
Fissurellidæa malleata, Tate	-	X	-	X
Hemitoma occlusa, Tate, m.s.	X	X	-	X
Emarginula cymbium, Tate, m.s.	-	X	-	X
† Scaphander fragilis, Tate, m.s.	X	X	-	X
† Ringicula sp.	X	X	-	X
Cylichna exigua, T. Woods	X	X	X	X
Class, Scaphopoda.				
Entalis Mantelli, Zittel	X	X	X	X
„ subfissura, Tate	X	X	X	X
Dentalium aratum, Tate	-	X	X	X
Class Cephalopoda.				
Nautilus sp. 1.	-	X	-	-
Nautilus sp. 2.=Gellibrand R. species	-	-	-	X
Class Pisces.				
† Otoliths	X	X	X	X

SUMMARY FOR LOCALITY 2.

Class.	No. of Species.
Actinozoa - - -	3
Echinodermata - -	1
Palliobranchiata - -	1
Lamellibranchiata - -	25
Gastropoda - - -	102
Scaphopoda - - -	3
Cephalopoda - - -	2
Total - - -	137

The following are the only previous records we have seen of fossils from this locality.

Prod. Pal. Vic., Dec. I., p. 28—*Voluta antiscalaris*, McCoy, recorded as "Common in the Tertiary Clays of $A^{d.}$ 14, parish of Moolap."

Id. Dec. III., p. 38—*Trivia avellanoides*, McCoy "very rare and of small size in blue clay ($A^{d.}$ 14) Outer Geelong Harbour."

Id. Dec. IV., p. 14—*Pecten Yahlensis*, T. Woods, "of large size $A^{d.}$ 12;" also *id.*, p. 26—*Voluta strophodon*, McCoy, "Abundant in blue Oligocene Tertiary Clays of Moolap ($A^{d.}$ 14)."

Id. Dec. VI., p. 40—*Lovenia Forbesi*, Duncan, "from Miocene beds of beach at Outer Geelong Harbour, ($A^{d.}$ 12)."

Taking only the Mollusca proper from the two localities we have recorded 150 species distributed as follows:—

Class.	No. of Species.
Lamellibranchiata - -	25
Additional Lamellibranchiata from Locality 1. - -	8
Gastropoda - - -	102
Additional Gastropoda from Locality 1. - -	10
Scaphopoda - - -	3
Cephalopoda - - -	2
Total - - -	150

Of these 150 species only three are represented in living-creation, which, therefore, gives us only two per cent. of living species. Several of the species however have not yet received specific names, but so far as the study of them has gone up to the present, it does not seem possible to refer any of them to living species.

By an inspection of the above list it will be seen to include many of our most characteristic Eocene fossils, and from the accompanying table the close relationship to other characteristic Eocene localities is obvious.

The fossils throughout the dark clays are in a very good state of preservation though the clays are very wet, and this which much increases their tenaceous character also greatly increases the difficulty in procuring specimens without damage, and it is of very little use to attempt to clean the specimens for purposes of identification until they have dried considerably.

A few remarks on some of the fossils might not be out of place. Two of the species namely, *Waldheimia divaricata*, and *Peristernia Morundiana*, have hitherto only been obtained from the River Murray Cliffs, and it is a very interesting fact to find them also in this locality. There can be no doubt whatever about these identifications, as they have been carefully compared with actual specimens from the typical locality.

Pecten dichotomalis is an interesting shell which is at present only recorded from Schnapper Point and the Gellibrand River and is not particularly common at either of these localities.

A new *Fusus* should be noted, examples of which have also been obtained from Schnapper Point. This remarkable shell will no doubt form the type of a sub-genus as it possesses such marked characters of its own, the whorls are wholly disjoined, the canal is almost closed, and the whole shell roughly speaking is somewhat like the columella of some fusoid shell divested of the whorls, the embryonic whorls are however in contact and are terminated by a projecting apex.

Some specimens of a new species of *Phos* were obtained which show strong affinities to the undescribed species occurring at Spring Creek, but owing to the fact that the Spring Creek examples are not in a very good condition nothing very definite about their identity can be said at present. The new species of

Voluta are worth mention. The first is a shell of the type of *V. lirata*, Johnston, but it differs from this species in many points, amongst others the absence of costæ is conspicuous.

The second shell is identical with a new species occurring at Spring Creek, which, in the adult form is quite seven inches in length with a characteristic long and slender spire terminated by an embryo with a markedly exsert tip.

The third, though an incomplete example, shows sufficient characters to designate it a new species with certain affinities to an undescribed species from Muddy Creek, which is related to *V. Stephensi*, Johnston, of Table Cape.

The fourth species belongs to the sub-genus *Volutoconus* and has its nearest ally in *V. conoidea*, but it is readily distinguishable from this species as the spire is much shorter and the whorls more tumid.

Cypræa Mulderi, Tate, is a shell we were not at all sorry to see turn up, as the only two examples previously found were obtained in sinking a deep well in Belmont. The type specimen is in the Adelaide University Museum and the second one is the property of Mr. Mulder of Geelong. Two additional examples were obtained.

A small and very pretty undescribed species of *Nautilus* turned up, which is apparently identical with the one occurring at the Gellibrand River and Muddy Creek.

The amount of disturbance in eocene strata as shown here is apparently unparalleled in Southern Australia and is evidently merely local. The polyzoal rock in M'Cann's quarry at Waurn Ponds dips S. 10° E. at 3° or 4°. The sandy limestones at Belmont, on the river bank just above Barwon bridge, dip E. 40° S. 10°. While between these two localities in the bed of the Waurn Ponds Creek, about 300 yards below where the Geelong to Colac road crosses it, the dip is N. 25° W. 7°. The Muddy Creek beds are stated by Mr. J. Dennant* to be horizontal, while Professor Tate, speaking generally of the Older Tertiaries of Southern Australia, says† that "for the most part secular elevation of the Older Tertiary sea bed has been of small amount and uniform."

* Trans. Roy. Soc. S.A., 1888, p. 33. † Proc. Roy. Soc. N.S.W., 1888, p. 241.

An instance of a high dip in older tertiary strata is however recently quoted by Mr. T. S. Hart* as occurring on the cliff-section near Mentone, and is given as S. 20° E. at 30°, with fractures and slight faulting. The rest of the section shows a very low dip, this high angle being noted in one fold only.

The high dip, contortion and the changed character of the small area of polyzoal rock exposed, point to subsequent volcanic disturbance, though no trace of igneous rock overlying the fossiliferous strata was found. Possibly no great discharge of solid material took place, but heated gases caused the slight metamorphism of the limestones.

The Clifton Mineral Springs, plentifully charged with carbonic acid gas, possibly represent the dying, or solfatara stage, of this outburst.

To the westward of the Curlewis section, the Bellarine Hills rapidly drop to the level of the plain, that separates them from the Geelong Hills, and the eocenes disappear from view. The upper tertiary beds are very thick and apparently form the greater part of the cliffs about the west end of the section, as the gully exposures gave no indication of the existence of any of the older beds, but showed mottled clays sands and conglomerates, and were, as far as we saw, unfossiliferous.

As almost the whole of the visible portion of the eocene beds of this section is exposed only between tide marks, advantage must be taken of low-tides to thoroughly examine the deposit, and this materially shortens the time available for work; besides which, only small portions of shells are visible above the surface as the pebbles and pyrites nodules soon destroy the projecting portions of the fossils. The clay beds, as at Mornington, are inhabited by great numbers of *Barnea australasiae* and *B. similis.* One peculiar feature of the beach is the manner in which the seaweed and shells are consolidated into a peaty mass, the pieces of wood enclosed looking like lignite.

A note on the ¼ sheet (23 S.W.) states that a shaft to the east of Fenwick's Gully showed 61 feet of ferruginous sands and clays overlying seven feet of black sandy clay with nodules of pyrites and fragments of lignite. This latter is called 'miocene,' presumably

* Vict. Nat., vol. ix., p. 157.

as it was thought to resemble the other plant beds of the colony which are ascribed to that age. Now these plant beds at Flemington, Berwick, Dargo High Plains and other places* where they are associated with the Older Volcanic rock, underlie it. However there are certainly good grounds for doubting the age ascribed to the volcanic rock. At Flinders, a small patch of polyzoal rock lies on the deeply eroded surface of the igneous series. The limestone being crowded with foraminifera such as Amphistegina (very common) Operculina and Orbitoides shows an approach in character to the Orbitoides limestone which we showed† lay at the base of the Moorabool Valley beds. At Eagle's Nest, near Airey's Inlet, the so called miocene also, as shown by the sections of the Survey, overlies the volcanic rock. Palæontological evidence is gradually accumulating to show that the ferruginous beds of Royal Park, near Melbourne, also belong to the eocene series, and these beds, as the cutting, for instance, in the park shows, lie also on the deeply eroded surface of the volcanic rock. Here at Curlewis, we show the same sequence. Selwyn‡ says that "the products of both volcanic periods are often contemporaneous, and interstratified, with the marine limestones." The only specific instances we can find quoted of this intercalation, in reference to the Older Volcanic, are the Maude sections on the Moorabool River, and Sutherland's Creek. As a rule then, there has been a considerable lapse of time between the volcanic flows and the deposition of the marine eocene beds. Should the Survey reading of the Maude section prove the correct one, some subdivision of the Older Volcanic series will be required, as a rock, the surface of which is deeply eroded before being covered with a marine deposit, can hardly be ascribed to the same age as a sheet intercalated with the latter. That the officers of the Survey have felt the need of some such division is shown by the legend attached to the older volcanic rock of the Bellarine Hills (¼ sheets 23 N.E. and 23 S.E.) namely 'miocene or older.' That it certainly is older is shown by the fact that the clays which are marked as miocene on the map, but which were subsequently stated by Prof. McCoy to be Oligocene,§ distinctly overlie it. The lower tertiary beds of this

* Murray, Geol. and Phys. Geog. of Vict., p. 104, et seg.

† Proc. Roy. Soc. Vict., vol. iv., N.S., p. 11.

‡ *Exhib.* Essays, 1866, p. 31. § Prod. Pal. Vic., Dec. iv., p. 26.

area are clearly of the same age as the typical eocenes of Muddy Creek. The plant beds then must come in, either at the base of the eocene series, or may possibly be even of cretaceous age.

Professor Tate has already indicated his discovery in South Australia of beds containing plant remains, which were orginally referred to Miocene age, occurring in conjunction with marine Cretaceous fossils, giving us a somewhat parallel case to the famous Laramie Beds of North America. In the vicinity of Adelaide, beds containing carbonaceous matter are also known to occur directly underlying the Eocene Tertiary as proved by the Adelaide bore.

Plant beds are extensively developed in New South Wales, and Wilkinson* states that they show "a perfect resemblance to the Lower Miocene leaf beds of Bacchus Marsh in Victoria; some of the impressions in the form seem to be undistinguishable from the Victorian fossils." Some of the New South Wales plant beds have been referred by Baron von Ettingshausen† to eocene age, apparently solely based upon the plant remains themselves. The discussions on the age of the New South Wales coal series and of the Laramie Beds of North America, go to show that very little weight can be attached to the evidence afforded by terrestrial or freshwater forms of life. The evidence which has been obtained in South Australia and Victoria is of a more definite nature, and at present seems to point to the Cretaceous age of the older deposits containing plant remains.

From Clifton Springs to Lake Connewarre, the surface is covered everywhere with a thick mantle of Upper Tertiary rocks, consisting of clays, loose sands and quartz gravels. Along the lake margin, and extending some distance inland, ferruginous grits are the almost universal representatives of these beds. They are of a dark-brown hue, coarse grained, fairly hard, and afford the common road metal of the southern part of the district, About a mile N.E. of Drysdale occurs a coarse sandstone with a siliceous cement which is used as road metal near Portarlington. The quartz is glassy and in some cases shows crystalline faces. The rock is of a whitish colour, somewhat cavernous, the cavities being sometimes coated with limonite.

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* Notes on the Geology of N.S.W., 1882, p. 56.

† Mem. Geo. Surv. N.S.W., Pal. No. 2. Contributions to the Tertiary Flora of Australia, 1888, p. 7.

From near the place at which the Barwon enters the lake, to the south end of Kissing Point, which is the Southern termination of Leopold Hill, basalt flanks the hill but does not rise much above the level of the lake. It is clearly a severed portion of the flow forming the plain to the south and west on the southern side of the lake. At Barwon Heads, the same rock is seen to be overlain by the Dune limestone of Mount Colite, and is referred on the ¼ sheet to Mount Duneed.

At the south end of Kissing Point, and overlying the basalt, occurs a bed of shells consisting of large oysters and *Barbatia trapezia*. It is about 20 feet above the lake level and is possibly a native shell-mound.

The great mass of the hill at this point is formed of a peculiar sandy limestone, in which no identifiable fossils could be detected. The officers of the Survey, in default of fossils, refer it doubtfully to miocene age. In appearance it somewhat resembles a dune limestone, though as we could not find a good section, we could not detect any false bedding in it. A similiar rock is marked as occurring at Bald Hill across the lake, but we did not visit it. We could not come to any conclusion about the age of this rock, but have not seen any eocene strata which resemble it closely.

From Campbell's Point to the north-west corner of the lake, gray clays constantly appear on the beach floor, and are overlain by yellow earthy limestone just above water level. Apparently the beds do not rise to any height on the cliffs as we saw no exposure anywhere.

Fossils from Point Campbell.

Class, *Actinozoa*.

Order, *Zoantharia*.

Balanophyllia Australiensis, Duncan.

Class, *Polyzoa*.

Numerous genera and species.

Class, *Lamellibranchiata*.

Ostrea sp.

Dimya dissimilis, Tate.

Nucula Atkinsoni, Johnston.

Limopsis Belcheri, Adams and Reeve.

Pectunculus laticostatus, Quoy and Gaimard.
Cucullæa Corioensis, McCoy.
Crassatella Dennanti, Tate.
Cardita polynema, Tate.
Chione sp. (?)
Corbula ephamilla, Tate.
„ pixidata, Tate.

Class, Gastropoda.

Triton Woodsii, Tate.
Fusus senticosus, Tate.
Fasciolaria exilis, Tate.
Dennantia Ino, T. Woods.
Dolichotoma atractoides, Tate, m.s.
Conus heterospira, Tate.
Cypræa sp. (? platypyga).
Natica polita, T. Woods.
Solarium acutum, T. Woods.
Turritella platyspira, T. Woods.
Vermetus conohelix, T. Woods.
„ sp.
Cerithium crebarioides, T. Woods.

Class, Scaphopoda.

Entalis Mantelli, Zittel.
„ subfissura, Tate.

Class, Pisces.

Otoliths.

FOSSILS FROM POINT CAMPBELL.

SUMMARY.

Class.	No. of Species.
Actinozoa - - -	1
Lamellibranchiata - -	11
Gastropoda - - -	13
Scaphopoda - - -	2
Pisces - - - -	1
Total - - -	28

From here to Fenwick's Gully, only Upper Tertiary beds were seen along the shore. On following up the gully the yellow earthy limestone, which forms the upper portion of the eocenes in the Geelong district, was seen outcropping frequently. It is overlain by a white earthy travertin, which is derived from it, and is burned for lime in the district. To the north of the Queenscliff Road, is a quarry on the side of the gully, which has for many years supplied the road with metal.

The hard rock occurs in narrow irregular bands, varying from a foot to a few inches in thickness. The rest of the deposit consists of yellow earthy limestone of a softer texture. The hard bands are composed of a fawn-coloured, granular, siliceous limestone which rings under the hammer and breaks with a clean sharp fracture. Sir Richard Daintree, who analysed it, states its composition to be as follows*.

Carbonate of lime	75·20
" " magnesia	3·00
Silica	15·79
Alumina and peroxide of iron ...	3·00
	96·99

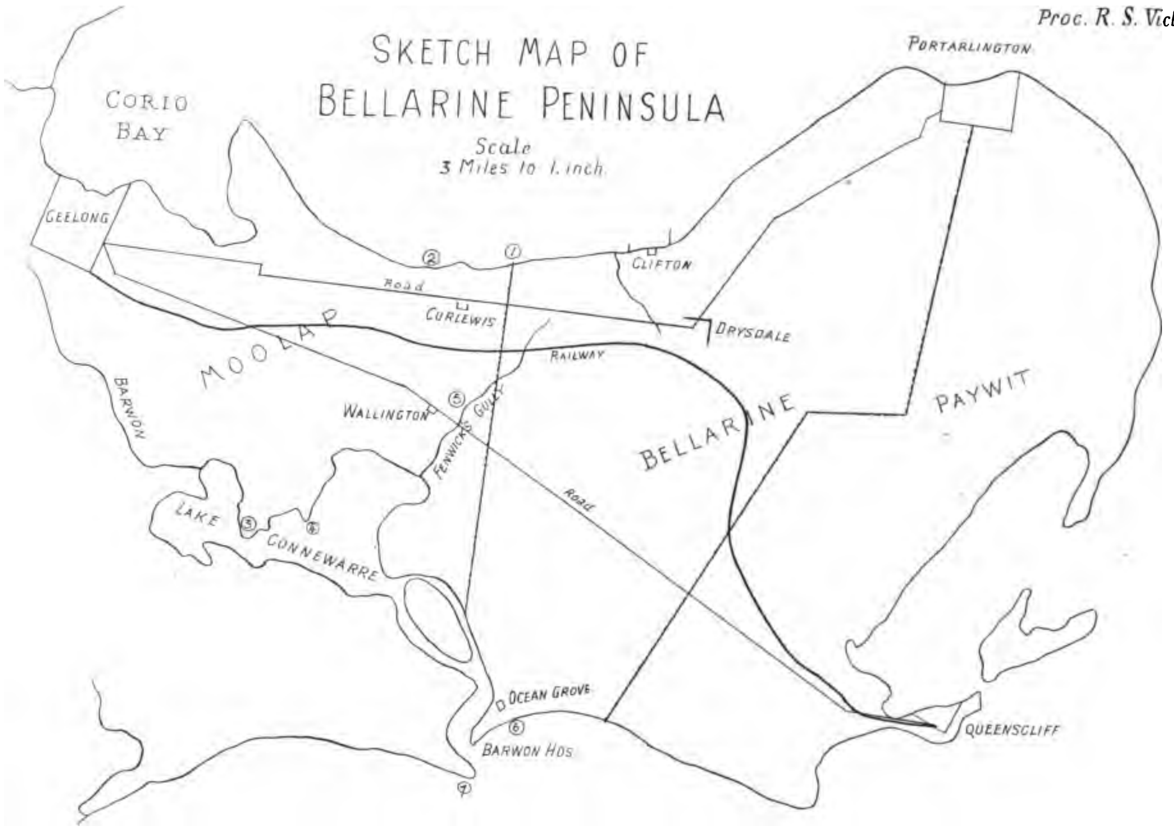
The following are the fossils obtained from this locality, owing however to the very hard nature of the rock, it is a somewhat difficult matter to collect any number of specimens.

Placotrochus deltoideus, Duncan.
Lovenia Forbesi, Duncan.
Dimya dissimilis, Tate.
Marginella propinqua, Tate.
? Ancillaria sp.
Cypræa sp. (cast probably leptorphyncha).
Turritella sp.

From an inspection of the above list, the horizon to which these rocks belong will be readily recognised as eocene.

Between the mouth of the gully and Ocean Grove the ¼ sheet (29 N.W.) marks a continuous outcrop of lower tertiary strata. Although we followed the margin of the lake between these two

* Selwyn and Ulrich. Ex. Essays, 1866, pp. 35 and 73.


SKETCH MAP OF
BELLARINE PENINSULA
Scale
3 Miles to 1. inch
CORIO
BAY
GEELONG
PORTARLINGTON
CLIFTON
DRYSDALE
CURLEWIS
Road
RAILWAY
MOOLAP
WALLINGTON
FENWICK'S GULLY
BELLARINE
PAYWIT
BARWON
LAKE
CONNEWARRE
Road
OCEAN GROVE
BARWON HDS.
QUEENSCLIFF
1
2
3
4
5
6
7

points, the time at our disposal was too short for any detailed examination, and we saw no exposure of these beds till we neared Ocean Grove. The hills are covered with a thick deposit of ferruginous grits, quartz gravels and mottled clays while still more recent deposits from the beach of the lake. Near Ocean Grove a well sinking on the flat showed that the earthy limestone lay at no great distance beneath the surface. The sea cliff gave a section showing an earthy sandy limestone varying in colour from yellow to brown and containing flakes of black mica. After spending considerable time in endeavouring to obtain some fossils from the limestone which crops out on the cliff-face just below the Coffee Palace, we managed to get *Terebratulina Davidsoni*, (Eth. fil.), fragments of Echinoderms and of a species of pecten.

The same rock crops out on the sandy shore of the beach below high water mark, and Mr. J. Bracebridge Wilson stated* that he has dredged up fragments of it at some distance off the shore here. Eocene fossils are occasionally washed ashore on tne beach a couple of miles west of Barwon Heads, where one of us has found about half-a-dozen specimens while gathering recent shells.

We have to express our indebtedness to the collecting of Mr. Mulder of Geelong for some of the information as regards the fossils from Belmont.

REFERENCES TO SKETCH MAP.

(Plate I).

1. Number 1 station. } The Curlewis section.
2. Number 2 station. }
3. Kissing Point.
4. Campbell's Point.
5. Quarry, Fenwick's Gully.
6. Cliff section, Ocean Grove.
7. Mount Colite.

* Proc. Roy. Soc. Vic., vol. iv., N.S., p. 221 (discussion).

Art. II.—*The Lizards indigenous to Victoria.*

(With Plate II.)

By A. H. S. Lucas, M.A., B.Sc., and C. Frost, F.L.S.

[Read 13th April, 1893].

The arrangement which we have adopted is that followed by Mr. G. A. Boulenger in the *Catalogue of the Lizards in the British Museum*, 2nd Edition, London, 1885. The characters of the Families, of the Genera, and of most of the Species have been taken from that work, in some cases verbatim, and in others in a slightly modified form. In all cases we have carefully verified the descriptions by the examination of as many specimens as we could obtain, and the modifications and additions which we have made have been suggested by our own observations, frequently made upon the living animals. We have included all the information which we have been able to gather as to the habits and the distributions of the lizards. The colouration of adult lizards we find to vary within wide limits in the case of many of the species, but the colour and pattern of the adults can often be explained and understood if considered as derived from the colour and pattern of young individuals, in which they are usually much more marked and constant. We have therefore, when able, described in some detail the colouration of young specimens. We have had the advantage of studying all the specimens preserved in the National Museum of Victoria, and we have to acknowledge, gratefully, the kindness and courtesy of Sir Frederick McCoy in placing the collection at our disposal for examination. We desire also to thank the following gentlemen who have assisted us in obtaining material: Professor W. B. Spencer, Dr. Dendy, C. French, Esq., F.L.S., Dudley Le Souëf, Esq., Assistant Director of the Melbourne Zoological Gardens, W. von Fremersdorff, Esq., Director of the Maryborough School of Mines, Thomas Steel, Esq., F.C.S., the Rev. E. H. Hennell, Geo. Lyell, Junr., Esq., C. C. Brittlebank, Esq., F. Reader, Esq., C. French, Junr., Esq., G. Morton, Esq., C. Martin, Esq., H. Giles, Esq., and R. Embleton, Esq.

GECKONIDÆ.

CHARACTERS OF THE FAMILY.

External Form.

Head and *body* more or less depressed, sometimes bordered by cutaneous expansions. *Tongue* fleshy, moderately elongate, very feebly incised anteriorly, capable of protrusion out of the mouth.

Tail presenting almost every possible shape, sometimes prehensile, almost always extremely fragile and rapidly reproduced. If reproduced it generally assumes an abnormal form and scaling.

Limbs, both pairs well developed, pentadactyle. The digits vary considerably and furnish the characters upon which the systematic arrangement is based.

Eye and *Ear.*—The eye generally large, with vertical pupil, covered as in Snakes, by a transparent lid under which it moves freely, the valvular lids being in most cases rudimentary. The tympanum usually more or less exposed.

Teguments.

Skin nearly always soft, with numerous tubercles or granules on the dorsal surface, and small, imbricated, cycloid or hexagonal scales on the ventral surface. Plate-like scales of the head only around the margin of the gape. The skin of the head usually free from the skull-bones.

Endo-skeleton.

Skull generally much depressed, with thin bones. Distinct nasals. Jugal rudimentary, the orbit not being bounded posteriorly by a long arch. No postfronto-squamosal arch. Pterygoids widely separated, without teeth. A columella cranii. Mandible of five bones, the angular and articular having coalesced.

Teeth pleurodont, small, numerous, closely set, with long, slender, cylindrical shaft and obtuse point. The new teeth hollow out the base of the old ones.

Vertebræ amphicœlous. Ribs long, and so prolonged as to form more or less ossified hoops across the whole abdominal region.

Limb-arches.—Clavicle dilated, perforated proximally. Interclavicle subrhomboidal to cruciform. Bones of the limbs, including those of the digits, well developed.

Mode of reproduction.

Oviparous. Eggs round, with a hard shell.

GYMNODACTYLUS, Spix.

Digits not dilated, clawed, cylindrical or slightly depressed at the base; the two or three distal phalanges compressed, forming an angle with the basal portion of the digits; the claw between two enlarged scales, (a superior and an inferior), of which the inferior is more or less deeply notched under the claw; digits inferiorly with a row of more or less distinct transverse plates.

Body variously scaled. Pupil vertical. Males with or without præanal or femoral pores.

The genus as defined ranges over Australia; the islands of the Pacific; Tropical America; the borders of the Mediterranean; Southern Asia. The species with greatly swollen or broadened tails, forming the section *Phyllurus*, Fitzing, are confined to Australia.

GYMNODACTYLUS MILIUSII, Bory.

Phyllurus miliusii, Gray, Cat., p. 176.

Phyllurus miliusii, Bory de St. Vincent, Dict. Hist. Nat. vii., p. 183, pl.—fig. 1; Gray, Zool. Erebus and Terror, pl. xvii., fig. 2; McCoy, Prodr. Zool. Vict., pl. 132.

Cyrtodactylus nilii, Gray, Griff, A.K. ix. Syn., p. 52.

Gymnodactylus miliusii, Dum. and Bibr. iii., p. 430, pl. xxxiii., fig. 1; Peters, Mon. Berl. Ac., 1863, p. 229.

Gymnodactylus (Anomalurus) miliusii, Fitz. Syst. Rept., p. 90.

Description.—" Head large oviform; snout a little longer than the diameter of the orbit, as long as the distance between the eye and the ear-opening; forehead and loreal region concave; ear-opening elliptical, vertical, about three-fifths the diameter of the eye. Body moderate. Limbs long, slender; digits rather short, subcylindrical. Snout covered with granules of unequal size; hinder part of head with minute granules intermixed with round tubercles; rostral subquadrangular, three times as broad as high; nostril directed posteriorly, separated from the rostral and first labial by two nasals; labials small, eleven to fourteen upper and ten to twelve lower; mental broadly trapezoid; no regular chin-

shields; gular granules minute. Body and limbs covered above with small granules intermixed with small round conical tubercles; belly covered with flat granules. Tail short, thick, swollen, and nearly as broad as the body in its anterior half, depressed, tapering to a fine point posteriorly; it is covered with small granules, and, on the upper surface, small conical tubercles arranged in transverse series. *Colour.*—Chestnut-brown above, with white cross bands on the back and tail; head and limbs white-spotted; lower surfaces white.

Total length	...	...	135	mm.
Head ...	...	...	25	„
Width of head ...		...	19	„
Body ...	...	...	65	„
Fore-limb	...	...	36	„
Hind-limb	...	...	43	„
Tail ...	...	...	55	„ "—Boulenger.

Distribution.—Victoria: Bendigo, Kangaroo Flat, Castlemaine, Mount Tallangower (Melb. Museum); Maryborough, Dimboola, Baringhup (L. and. F.).

Range outside Victoria.—Western Australia (Melb. Mus.); Sydney, Champion Bay, N.W. Australia (Brit. Mus.).

PHYLLODACTYLUS, Gray.

Digits more or less slender, free, all clawed, with transverse lamellæ or tubercles inferiorly; the extremity more or less dilated, with two large plates inferiorly, separated by a longitudinal groove in which the claw is retractile; the distal expansion covered above with scales strongly differentiated from those on the basal portion of the digit.

Upper surfaces covered with juxtaposed scales, uniform or intermixed with larger tubercles; abdominal scales generally imbricate.

Pupil vertical.

Males with neither præanal nor femoral pores.

The genus extends over Australia; Africa; islands of the Mediterranean; Tropical America.

PHYLLODACTYLUS MARMORATUS, Gray.

Diplodactylus marmoratus, Gray, Cat., p. 149.

Diplodactylus marmoratus, Gray, Zool. Erebus and Terror, pl. xv., fig. 6; McCoy, Prodr. Zool. Vict., pl. 132.

Phyllodactylus porphyreus, part, Dum. and Bibr. iii., p. 393.

Phyllodactylus peronii, Fitz. Syst. Rept., p. 95.

Description.—"Head oviform, much longer than broad; snout rounded, a little longer than the distance between the eye and the ear-opening, once and two-fifths the diameter of the orbit; forehead very slightly concave; ear-opening small, roundish or oval, its diameter one-third to one-half that of the eye. Body rather elongate; limbs moderate. Digits not much depressed; digital expansions moderate, rounded, subtrapezoid; the diameter of the disk of the fourth toe equals two-thirds the diameter of the eye; the slender part of the digit with regular transverse lamellæ inferiorly, which are broken up into small scales a short distance in advance of the distal expansion; seven or eight entire lamellæ under the fourth toe. Upper surfaces covered with uniform small granules, largest on the snout, smallest on the hinder part of the head. Rostral pentagonal or hexagonal, the posterior angle being truncate, the latero-superior angles touching the nostril; the latter is pierced posteriorly to the suture of the rostral and first labial, and between the latter and three nasals; eight or nine upper and as many lower labials; mental trapezoid or pentagonal, not larger than the adjacent labials; no regular chin-shields, but small polygonal scales, passing gradually into the minute granules of the gular region. Abdominal scales moderate, smooth subhexagonal, slightly imbricate. Tail long, cylindrical, tapering in its posterior half, covered with uniform small smooth scales, rather large inferiorly, arranged in rings. *Colour.*—Greyish or reddish-brown above, variegated with dark-brown; whitish inferiorly.

Total length	... ...	119 mm.
Head ...	... ...	13 „
Width of head ...	...	10 „
Body ...	... ...	38 „
Fore-limb	... ...	17 „
Hind-limb	... ...	21 „
Tail ...	... ...	68 „ "—Boulenger.

Habits.—Usually met with under logs and flat stones.

Distribution.—Victoria: Heathcote, Goulburn Valley, Murray District, Pyramid Hill, Gunbower, Murchison, Echuca, Western District (Melb. Mus.); Castlemaine, Maryborough, Dimboola, Grampians (L. and F.).

Range outside Victoria.—Western Australia, Houtman's Abrolhos, Kangaroo Island (Brit. Mus.).

DIPLODACTYLUS, Gray.

Digits free, not dilated at the base, slightly at the apex, all clawed, the claw retractile between two plates under the extremity of the digits; the basal portion of the digits inferiorly with transverse lamellæ or tubercles; the upper surface of the digits covered with uniform small tubercular scales.

Upper surfaces covered with juxtaposed scales, uniform or intermixed with larger tubercles; abdominal scales juxtaposed.

Pupil vertical.

Males with or without præanal pores, without femoral pores.

The genus extends over the whole of Australia, but is not met with outside of the Continent.

DIPLODACTYLUS STROPHURUS, Dum. and Bibr.

Phyllodactylus strophurus, Dum. and Bibr., iii., p. 397, pl. xxxii., fig. 1.

Discodactylus (Strophurus) dumerilii, Fitz. Syst. Rept., p. 96.

Description.—Head oviform, convex; snout rounded, rather longer than the distance between the eye and the ear-opening, longer than the diameter of the orbit; eye large; ear-opening small, roundish. Body and limbs moderate. Digits much depressed, with large transverse lamellæ inferiorly, about seven under the fourth toe, the middle ones chevron-shaped, the distal one heart-shaped, the basal ones divided into two rounded plates; the plates under the apex of the digit large, together cordiform. Upper surfaces covered with minute granules, with two somewhat irregular longitudinal series of large very obtusely conical tubercles along the back and tail. Rostral pentagonal, completely divided medially; nostril pierced between the rostral, the first labial and

three or four nasals; thirteen or fourteen upper labials, about the same number of lower labials; mental small, trapezoid, scarcely larger than the adjacent labials; no chin-shields. Lower surfaces covered with small juxtaposed granules. Males with a doubly arched series of eleven to fourteen præanal pores, and three or four large conical tubercles at the base of the tail. Tail short, subcylindrical, prehensile, covered with small granules; on each side of its upper surface the series of tubercles above-mentioned. *Colour.*—Upper surfaces olive-grey, speckled or pencilled with black; tubercles brown; head with dark undulations of which two are longitudinal on each side of the snout, one passing through the eye, the other meeting its fellow above on the snout.

Distribution.—Victoria: Kewell, near Dimboola, Murray District (Melb. Mus.); Lake Albacutya (L. and F.).

Range outside Victoria.—New South Wales, Sydney (Brit. Mus.).

DIPLODACTYLUS VITTATUS, Gray.

Diplodactylus vittatus, Gray, Cat., p. 148.

Diplodactylus ornatus, Gray, Cat., p. 149.

Diplodactylus vittatus, Gray, P.Z.S., 1832, p. 40 and Zool. Erebus and Terror, pl. xvi., fig. 3.

Phyllodactylus vittatus, Dum. and Bibr. iii., p. 400.

Diplodactylus furcosus, Peters, Mon. Berl. Ac., 1863, p. 229.

Diplodactylus ornatus, Gray, Zool. Erebus and Terror, pl. xvi., fig. 2.

Description.—"Head short, very convex; snout rounded-acuminate, measuring the diameter of the orbit or the distance between the eye and the ear-opening; latter rather small, round. Body short; limbs moderate. Digits short, depressed, with small apical dilatation, inferiorly with a series of transversely oval tubercles, some of them breaking up into two rounded tubercles; the extremity of the digit is raised and bears inferiorly two roundish plates separated from the large tubercles of the basal part by three or four rows of small granules. Upper surfaces covered with uniform small granular scales. Rostral four-sided, twice as broad as high, with median cleft above;

nostril pierced between the rostral, the first labial and five or six nasals, the anterior or upper largest and generally in contact with its fellow, the others granular; ten or eleven upper and as many lower labials; mental trapezoid, a little larger than the adjacent labials; no chin-shields. Abdominal scales granular, scarcely larger than those on the upper surfaces. Tail short, swollen, root-shaped, with rings of uniform small squarish scales. Male with a small group of conical tubercles on each side the base of the tail. *Colour.*—Brown above; a light dark-edged festooned vertebral band, bifurcating on the nape, sometimes broken up into angular spots; sides and limbs with light spots; lower surfaces dirty-white.

Total length	...	...	88	mm.
Head ...	...	...	15	„
Width of head ...		...	12	„
Body ...	...	...	40	„
Fore-limb	...	...	19	„
Hind-limb	...	...	24	„
Tail ...	...	...	33	„ "—Boulenger.

Habits.—This lizard is usually met with under thin flat stones near the tops of mountains.

Distribution.—Victoria: Bendigo, Upper Murray, Dimboola (L. and F.).

Range outside Victoria.—Western Australia, Champion Bay, Houtman's Abrolhos, Sydney (Brit. Mus.); Deniliquin, New South Wales (Melb. Mus.).

DIPLODACTYLUS TESSELLATUS, Günther.

Stenodactylopsis tessellatus, Günth., Zool. Erebus and Terror, p. 16.

Description.—"Head large, oviform, very convex; snout rounded, as long as the diameter of the orbit or the distance between the eye and the ear-opening; latter small, round. Body short; limbs long, slender. Digits rather long, slender, feebly depressed, not dilated at the end, inferiorly with small granules; apical plates small, oval. Head with small granular scales; rostral four-sided, emarginate above, more than twice as broad as

high, with trace of median cleft; nostril pierced between the rostral, the first labial, and six nasals; latter, anterior large, posterior very small granules; nine upper and ten lower labials; mental elongate, not larger than the adjacent labials; no chin-shields. Back covered with flat tessellated juxtaposed scales, much larger on the middle of the back. Abdominal scales flat, subimbricate, not half the size of the larger dorsal scales. Male with a group of conical tubercles on each side of the base of the tail. *Colour.*—Greyish-white above, with faint irregular brownish variegation; white beneath.

Total length	...	...	69	mm.
Head ...	...	...	14	,,
Width of head	...	...	9	,,
Body ...	...	...	34	,,
Fore-limb	...	...	19	,,
Hind-limb	...	...	23	,,
Tail ...	...	...	21	,, "—Boulenger.

Distribution. — Victoria: Kewell, near Dimboola, Western District (Melb. Mus.); Dimboola (L. and F.)

Gehyra, Gray.

Digits strongly dilated, free or webbed at the base, inferiorly with undivided or medially divided transverse lamellæ; distal phalanges free, elongate, compressed, clawed, raised from within the extremity of the dilatation; inner digits without free distal phalange, clawless, or with a very indistinct retractile claw.

Upper surfaces covered with granular scales; belly with cycloid imbricated scales.

Pupil vertical.

Male with femoral or præanal pores.

The genus extends over the East Indies; Australia; islands of the Indian and South Pacific Oceans; while one species, *G. mutilata*, Wiegm., reaches Western Mexico.

Gehyra variegata, Dum. and Bibr.

Peripia variegata, Gray, Cat., p. 159.
Hemidactylus variegatus, Dum. and Bibr., iii., p. 353.

Peropus (Dactyloperus) variegatus, Fitzing, Syst. Rept., p. 103.

Peripia torresiana, Günther, A.M.N.H. (4), xix., 1877, p. 415.

Description.—"Head longer than broad; snout longer than the distance between the eye and the ear-opening, about once and a half the diameter of the orbit; forehead with a median groove; ear-opening moderately large, suboval. Body and limbs moderately elongate, depressed, without cutaneous folds. Digits short, free or with a very slight rudiment of web: the inferior lamellæ angular, divided by a median groove. Tail depressed, tapering, the sides rounded. Upper surfaces and throat covered with very small granular scales; abdominal scales moderate. Rostral quadrangular, broader than high, with a median cleft superiorly; nostril pierced between the rostral, the first labial, and three nasals; seven to nine upper and six to eight lower labials; mental moderately large, pentagonal; chin-shields three pairs, inner largest, elongate, outer small, frequently broken up into small scales; these shields considerably shorter than in *G. mutilata*. The upper surface of the tail covered with very small flat scales, the lower surface with a median series of large transversely dilated scales."—Boulenger.

A short angular series of præanal pores, ten to sixteen altogether (in the males).

Colouration of half-grown specimen (in spirit).—Greyish-lavender above, browner on the head and limbs, with a pattern formed by darker narrow longitudinal and transverse wavy bands. One of these bands commences at the nostril, passes along the canthus rostralis and over the orbit, then curves inwards towards its fellow at the back of the head; these bands are darker and more definite on the snout, and are connected by a transverse band just above the nostrils, and by a second commissure less well defined higher up on the snout; the median surface included between the two curved bands is vermicularly marked and spotted. A second band on either side passes along the side of the snout below the first, crosses the eye, and continues as a longitudinal dorso-lateral band along the whole length of the trunk, becoming indistinct along the tail. A third much broken band still lower down on the side is indicated by a streak below the orbit, another through the ear-opening, and by a fainter more or less continuous band on the trunk and tail, below and parallel

to the dorso-lateral band. A number of transverse wavy bands are plainly marked across the back and proximal portion of the tail, becoming broken up on the sides into lines and spots. The upper surfaces of the limbs are variegated with irregular wavy bands and spots. The lower surfaces are of a nearly uniform greyish-white, the lamellæ of the digits darker.

In adult specimens of the dark markings the most persistent are the two upper bands on the sides of the head and neck, and the bands across the back.

Distribution.—Victoria: A single half-grown male specimen (with fourteen præanal pores) found by Dr. Dendy on the steamboat between Swan Hill and Mildura, which may have come on board from either the Victorian or New South Wales bank of the Murray. The species at all events reaches the borders of Victoria.

Range outside Victoria.—Houtman's Abrolhos, Champion Bay, Peak Downs, islands of Torres Straits, Murray I., Sunday I. (Brit. Mus.); Queensland (L. and F.).

[Since writing the above, two specimens of this lizard have been obtained from under the bark of a tree in the public park at Echuca.]

PYGOPODIDÆ.

Characters of the Family.

External Form.

Body elongate, snake-like. *Tongue* fleshy, papillose, elongate, more or less feebly incised anteriorly, extensible.

Tail long and fragile.

Limbs extremely reduced; no fore-limbs; hind-limb visible externally only as a scaly flap without distinct digits.

Eye and *Ear.*—The eye rather small, with broadly elliptical, vertical pupil, not protected by movable lids, usually with a circular scaly rudimentary lid. The tympanum either exposed or concealed under the scales.

Teguments.

The body is covered with roundish, imbricate scales, and the head is more or less regularly plated with larger scales. The skin of the head quite free from the subjacent skull-bones.

Endo-skeleton.

Skull rather depressed. Præmaxillary single, narrowed, much produced posteriorly between the nasals. Nasals distinct. Frontal single. Præfrontals and postfrontals in contact, separating the frontal from the orbit. Jugal rudimentary, there being no postorbital arch. No postfronto-squamosal arch. Pterygoids widely separated, without teeth. Mandible of four bones, the angular, supra-angular and articular having coalesced.

Teeth pleurodont, small, numerous, closely set.

Limb-arches.—Pectoral arch very rudimentary. The ischium appears externally as a small spur on each side behind the anal cleft. Bones of hind-limb, including phalanges of five toes, present but small.

Pygopus, Merr.

Parietal bones distinct. Tongue slightly nicked at the tip, with rows of large round papillæ inferiorly. Ear exposed. Rudiments of hind-limbs externally. Head with large symmetrical plates. Scales cycloid-hexagonal, imbricate, those on the back keeled, the two median series on the belly and the median series under the tail transverely enlarged, hexagonal. Præanal pores in both sexes.

The distribution of this monotypic genus is the same as that of the single species, Australia and Tasmania.

Pygopus lepidopus, Lacépède.

Pygopus lepidopus, Gray, Cat., p. 67.

Pygopus squamiceps, Gray, Cat., p. 68.

Bipes lepidopus, Lacép., Ann. Mus. iv., 1804, p. 209, pl. lv., fig. 1; Guérin, Icon. R. A., Rept., pl. lxi., fig. 1; Duvern. R. A., Rept., pl. xxii., vis. fig. 2.

Sheltopusik novæ-hollandiæ, Oppel. Ordn., p. 40.

Pygopus lepidopus, Merr. Tent., p. 77; Günther, Ann. Mag. N.H. (3) xx., 1867, p. 45; McCoy, Prodr. Zool. Vict., pl. 152, 153.

Hysteropus novæ-hollandiæ, Dum. and Bibr. v., p. 828, pl. lv.

Pygopus squamiceps, Gray, Zool. Erebus and Terror Rept., pl. viii., fig. 3.

Description.—"Snout scarcely prominent, rounded, as long as the distance between the orbit and the ear-opening; canthus rostralis obtuse; eye small, with rudimentary circular scaly lid; ear-opening oval, oblique. Tail, when intact, at least twice as long as the body. Rudimentary hind-limbs measuring about the distance between the eye and the end of the snout in females, more than the distance between the posterior border of the eye and the end of the snout in males. Ten to fourteen præanal pores. Rostral low, from twice and a half to thrice and a half as broad as high; nostril between the first labial and three nasals, the two anterior of which are band-like and extend across the upper surface of the snout, where they form a suture with their fellows, or are separated by one or two small azygos plates; a large polygonal præfrontal, separated from the nasals by two (or one) pairs of small transverse plates, its transversely truncate posterior border forming a suture with the frontal, which is pentagonal and about once and two-thirds as long as broad; the posterior angle of the latter plate wedged in between the pair of parietals, which are nearly as large as the frontal, and sub-hexagonal; sometimes a narrow band-like plate on the outer side of the parietals; two large supraorbitals; loreal region with numerous small polygonal plates, from four to seven in a row, between the orbit and nasal; five to seven upper labials, separated from the orbit by a row of scales; mental large, broadly trapezoid; four to six lower labials, the first or the first two much dilated vertically. Keels of the dorsal scales forming regular lines on the body, alternate on the tail. Twenty-two or twenty-three (in one specimen twenty-one) longitudinal series of scales round the middle of the body, ten smooth and twelve or thirteen (or eleven) keeled. The enlarged ventral scales twice as broad as long, in seventy to eighty-five longitudinal series. Two enlarged anal scales separated from the perforated præanal scales by one or two

rows of scales. *Colour.*—Coppery-grey above, uniform or with three or five longitudinal series of blackish dots or elongate quadrangular spots; lower surfaces more or less marbled or pulverated with grey.

	MALE.	FEMALE.
Head	16 ...	16 mm.
Width of head ...	10 ...	10 „
Body	165 ...	155 „
Hind-limb ...	11 ...	6 „
Tail	400 ...	345 „ "—Boulenger.

Distribution.—Victoria: Kewell in Western District, Gippsland (Melb. Mus.); common in northern part of the colony (McCoy); Murray District (L. and F.).

Range outside Victoria.—New South Wales, North and North-West Australia, Tasmania.

DELMA, Gray.

Parietal bones distinct. Tongue slightly nicked at the tip, with rows of large round papillæ inferiorly. Ear exposed. Rudiments of hind-limbs externally. Head with large symmetrical plates. Scales smooth, cycloid hexagonal, imbricate, the two median series on the belly and the median series under the tail transversely enlarged, hexagonal. No præanal pores.

Both species of the genus are confined to Australia.

DELMA FRASERI, Gray.

Delma fraseri, Gray, Cat., p. 68.

Delma fraseri, Gray, Zool. Misc., p. 14, and in Grey's Travels Austral. ii., p. 427, pl. iv., fig. 3; Günth. Ann. and Mag. N. H. (4) xii., 1873, p. 145; McCoy, Prodr. Zool. Vict., pl. 153.

Delma grayii, Smith, Ill. S. Afr. Rept., pl. lxxvi., fig. 2.

Delma mölleri, Lütken, Vidensk. Meddel., 1862, p. 296, pl. i., fig. 2.

Nisara grayii, Gray, Liz. Austr., p. 3.

Description.—"Snout not prominent, as long as the distance between the orbit and the ear-opening; canthus rostralis obtuse;

eye with distinct circular scaly lid; ear-opening elliptical, oblique, its diameter equal to that of the eye. Tail, when intact, three or four times as long as the body. The rudimentary hind-limbs measure about the length of the snout in males, considerably less in females. Rostral triangular or pentagonal, nearly twice as broad as high; nostril pierced between the first labial and three nasals (two in the specimen described as *D. mölleri*, in which the naso-rostral and upper nasal have fused) the two anterior of which form a suture with their fellows on the snout; exceptionally, however, the upper nasal is separated from the nostril; a pair of fronto-nasals; præfrontal large, a little broader than long, seven-sided, the antero-lateral sides very short, in contact with a large loreal; frontal as broad as or a little narrower than the præfrontal, longer than broad, seven-sided, its posterior angle wedged in between the pair of parietals, which are considerably larger than the frontal; a pair of enlarged scales on the outer side of the parietals; two large supraorbitals; a large loreal and four or five small plates between the orbit and the nasal; five or six upper labials, fourth much elongate and situated under the orbit from which it is separated by a row of small scales; mental large, triangular, broader than long; four lower labials, the two anterior much dilated vertically, the first forming a suture with its fellow behind the mental. Sixteen longitudinal rows of scales round the middle of the body. The enlarged ventral scales vary considerably in width, being sometimes not quite twice as broad as long, whilst in most specimens they are more than twice as broad as long; they form forty-five to sixty pairs. Two large and a smaller median anal scales. Olive above; head generally with four more or less confluent black cross bands, which may be separated by whitish bands; in two specimens these bands are indistinct, and the sides of the head and body are vertically barred with darker and whitish; one specimen uniform olive without any markings. Lower surfaces yellowish.

Head	13 mm.	
Width of head	7 „	
Body	85 „	
Hind-limb	4·5 „	
Tail	355 „	"—Boulenger.

Habits.—Found a few inches below the surface of the ground where it is often turned up by the plough.

Distribution.—Victoria: Melbourne, Wimmera, Kewell, near Dimboola (Melb. Mus.); Murray District (L. and F.).

Range outside Victoria.—Western Australia: Perth, Champion Bay, Nichol Bay; Queensland.

DELMA IMPAR, Fischer.

Pseudodelma impar, Fischer, Arch. f. Naturg., xlviii., 1882, p. 287, pl. xvi., figs. 1-4; McCoy, Prodr. Zool. Vic., pl. 161.

Description.—"Tail twice as long as head and body. Rudimentary limbs small. Rostral pentagonal; nostril pierced in the lower portion of the nasal, which forms a suture with its fellow on the snout; a pair of large plates between the nasals and the præfrontal; latter seven-sided, a little larger than the frontal, which is also seven-sided and smaller than the parietals; a band-like plate on the outer side of the latter; two supraorbitals; a large loreal and four small plates between the orbit and the nasal; seven upper labials, fourth elongate and situated below the orbit, from which it is separated by a row of small scales; mental large, triangular; six lower labials, the first forming a suture with its fellow behind the mental. Fifteen longitudinal rows of scales round the middle of the body. Two enlarged præanal scales. *Colour.*—Olive-green, lighter beneath; on each side of the back two light, dark-edged longitudinal lines. From snout to vent 80 mm.; tail 167 mm."—Boulenger.

Habits.—Found coiled up like a snake under stones in Spring. Large numbers were turned up by the pick and shovel in removing the surface soil in the construction of the sewers at Werribee.

Distribution.—Victoria: Melbourne district, Werribee River (Melb. Mus.); Maryborough (L. and F.)

Not recorded from outside Victoria.

APRASÍA, Gray.

Parietal bones distinct. Tongue rounded and slightly nicked at the tip. Ear concealed. Slight rudiments of hind limbs externally. Head with large symmetrical plates; no parietal

plates. Scales smooth, cycloid, imbricate, those on the belly scarcely enlarged. No præanal pores.

The single species is confined to Australia.

APRASIA PULCHELLA, Gray.

Aprasia pulchella, Gray, Cat., p. 68.

Aprasia pulchella, Gray, Ann. and Mag. N. H. ii., 1839, p. 332, and in Grey's Trav. Austral. ii., pl. iv., fig. 2; Lütken, Vidensk. Meddel., 1862, p. 300, pl. i., fig. 3; Günther, Ann. and Mag. N. H. (4), xii., 1873, p. 145; McCoy, Prodr. Zool. Vict., pl. 161, fig. 1.

Description.—" Head very small, with very prominent rounded snout; eyes well developed, with circular scaly rudimentary lid. Body calamiform. Tail shorter than the body, of subequal diameter throughout, its end obtuse, rounded. Rudiments of hind limbs extremely small, hardly distinct. Rostral very high, narrow, the portion seen from above the snout triangular; nostril pierced between the first labial and a very large nasal, which forms a suture with its fellow on the snout; a pair of large præfrontals, forming a suture with the second labial; a large hexagonal frontal, the posterior angle of which is rounded off; four or five enlarged occipital scales, but no parietals; a supra-orbital; a narrow præorbital; no loreal; five or six upper labials, third and fourth entering the orbit; mental large, broadly trapezoid; two or three lower labials, anterior very large. Twelve series of scales round the body. Three slightly enlarged anal scales. *Colour.*—Yellowish or pinkish, with eight dark-brown lines above following the longitudinal series of scales, or with series of brown dots arranged in four widely separated longitudinal series on the back and very crowded on the sides.

Head	6 mm.	
Body	112 ,,	
Tail	64 ,,	
Diameter of Body ...	3·5 ,,	"—Boulenger.

Distribution.—Victoria: Portland, Lake Wallace (Melb. Mus.). Range outside Victoria.—Western Australia (Brit. Mus.).

LIALIS, Gray.

Parietal bones coalesced. Teeth sharply pointed, directed backwards. Tongue elongate, narrowing towards the end, bifid. Ear exposed. Slight rudiments of hind limbs externally. Head covered with small plates. Scales soft, smooth, cycloid, imbricate, the two median series on the belly and the median series under the tail transversely enlarged, hexagonal. Præanal pores in both sexes, frequently indistinct in females.

This monotypic genus is found in Australia and in New Guinea.

LIALIS BURTONII, Gray.

Lialis burtonii, Gray, Cat., p. 69.

Lialis bicatenata, Gray, Cat., p. 69.

Lialis punctulata, Gray, Cat., p. 69.

Lialis burtonii, Gray, Proc. Zool. Soc., 1834, p. 134 ; Dum. and Bibr. v., p. 831 ; Gray in Grey's Trav. Austral. ii., p. 437, pl. iii., fig. 1, and Zool. Misc., p. 52, and Zool. Erebus and Terror Rept., p. 5, pl. viii., fig. 2 ; A. Dum. Cat. Méth. Rept., p. 194 ; Günther, Ann. Mag. N. H. (3) xx., 1867 p. 46 ; McCoy, Prodr. Zool. Vict. pl., 162.

Lialis bicatenate, Gray, Zool. Misc., p. 52, and Zool. Erebus and Terror, p. 5 ; Peters, Mon. Berl. Ac., 1873, p. 606.

Lialis punctulata, Gray, Zool. Misc., p. 52, and Zool. Erebus and Terror, p. 5, pl. viii., fig. 1 ; Günther, l.c.

Lialis leptorhyncha, Peters, l.c., p. 605.

Description.—"Snout narrow, depressed, long, acuminate, truncate at the tip, with angular canthus rostralis ; eye small, with circular scaly rudimentary lid ; ear-opening elliptical, oblique. Tail, when intact, nearly as long as head and body, gradually tapering to a fine point. Rudiments of hind-limbs extremely small, scarcely distinct, especially in females. Four or five præanal pores, frequently indistinct in females. Snout covered with small plates, variable in number and arrangement ; three supraorbitals, median large ; loreal region covered with numerous small scales ; the rest of the head with equal scales ; rostral very low ; nostril pierced in the posterior portion of a nasal ; thirteen to seventeen upper labials, all very small, separated from the

orbit by two or three rows of scales; mental rather large, trapezoid or pentagonal; twelve to sixteen lower labials; a series of dilated gular scales on each side, separated from the lower labials by one or two rows of scales. Nineteen or twenty-one (occasionally twenty, according to Peters) longitudinal rows of scales round the middle of the body; the dilated ventral scales in seventy to one hundred pairs. Three or five anal scales. *Colour.* — Ground-colour brown, gray, reddish, or yellowish, variously marked or uniform.

Head	...	...	...	27	mm.
Body	...	...	...	220	„
Tail ...	...	...	...	270	„

This lizard varies extremely in the degree of elongation of the snout, in the scutellation of the head, in the number of rows of scales, and in colour; but I am satisfied that the several forms hitherto described should be united into one species, which I divide into numerous varieties of colouration."—Boulenger.

Distribution.—Victoria: Wimmera.

Range outside Victoria. — Distributed over the whole of Australia and adjacent islands.

AGAMIDÆ.

Characters of the Family.

External Form.

Somewhat variable but usually with large *Head* and *Body* and long much tapering tail. Ornamental appendages, such as crests, gular pouches, braids and frills, are often present, either in males only or in both sexes. *Tongue* thick, entirely attached or slightly free in front, not or but slightly nicked anteriorly.

Tail usually long and not fragile.

Limbs, both pairs well-developed, almost always pentadactyle. The digits are usually keeled inferiorly or denticulated laterally.

Eye and *Ear*.—The eye small with circular pupil, protected by well-developed upper and lower movable eyelids. The tympanum exposed or concealed under the skin.

Teguments.

The skin always covered with scales; of which some are often conical or spinose. The head is not plated. The skin of the head quite free from the bones of the skull.

Endo-skeleton.

Skull not much depressed, strongly ossified. Premaxillary single. Nasals distinct. Frontal single. Parietal single. Postorbital arch present. Postfronto-squamosal arch present. Pterygoids widely separated, without teeth. A columella cranii and os transversum. Mandible.

Teeth acrodont, usually of three kinds, viz., incisors, canines and molars.

Limb-arches well-developed. Clavicle not dilated. Interclavicle T-shaped or anchor-shaped, frequently small. Sternum usually presents two fontanelles. Bones of limbs including those of digits, well developed.

Mode of reproduction.—Oviparous.

AMPHIBOLURUS, Wagler.

Tympanum distinct. Body more or less depressed. Dorsal crest absent or feebly developed. No gular sac; a strong transverse gular fold. Tail round or feebly compressed. Præanal and femoral pores.

Australia.

AMPHIBOLURUS ADELAIDENSIS, Gray.

Grammatophora angulifera, var. 2, Gray, Cat., p. 253.

Grammatophora muricata, var. adelaidensis, Gray in Grey's Trav. Austr. ii., p. 439.

Grammatophora adelaidensis, Gray, Zool. Erebus and Terror Rept., pl. xviii., fig. 2.

Description.—" Habit stout. Head short; snout nearly as long as the diameter of the orbit; nostril equally distant from

the eye and the end of the snout; tympanum scarcely half the diameter of the orbit; upper head-scales strongly keeled; small spinose tubercles on the back of the head; sides of neck strongly plicate; a more or less distinct dorso-lateral fold. Gular scales smaller than ventrals, keeled. Body much depressed, covered with irregular strongly keeled scales, largest on the vertebral region, intermixed with enlarged trihedral spinose scales forming very irregular longitudinal series; a more or less regular vertebral series of enlarged scales; ventral scales keeled. Limbs short, the adpressed hind-limb reaching the shoulder or the neck in females, the tympanum or a little beyond in males; scales on upper surface of limbs unequal, strongly keeled. A series of twenty to thirty pores extending on more than the proximal half of the thighs, continuous or interrupted on the præanal region. Tail round, depressed at the base, not once and two-thirds the length of head and body; scales strongly keeled at the base with four or five longitudinal series of enlarged ones, the outer series, on the side, composed of large trihedral tubercles. *Colour.*—Pale olive-grey above, with a regular series of angular dark-brown, white-edged spots on each side of the vertebral region, and another more or less regular along each side; head with symmetrical dark markings; limbs with irregular dark cross bars; tail with two series of dark spots; lower parts white, the throat marbled with black in the male, less distinctly with grey in the female; in the male an elongate black spot on the chest and blackish variegations on the chest and belly.

Total length	...	...	126	mm.
Head ...	...	...	13	„
Width of head	...	...	11	„
Body ...	...	.	35	„
Fore-limb	...	...	21	„
Hind-limb	...	...	33	„
Tail ...	...	...	78	„ "—Boulenger.

Distribution.—Victoria: Dimboola (L. and F.).

Range outside Victoria.—Western Australia (Swan River); var. *tasmanensis*, from Tasmania (Brit. Mus.).

AMPHIBOLURUS PICTUS, Peters.

Amphibolurus ornatus (non Gray) Peters, Mon. Berl. Ac., 1863, p. 230.

——— *pictus*, Peters, Mon. Berl. Ac., 1866, p. 88.

Grammatophora picta, Günth., Zool. Ereb. and Terr. Rept., p. 18.

Description.—" Habit stout. Head very short, snout shorter than the diameter of the orbit; nostril equally distant from the eye and the tip of the snout; tympanum large, nearly two-thirds the diameter of the orbit; upper head-scales subequal, tubercular, smallest on the supraorbital region; a series of enlarged scales from the nostril to above the tympanum, passing below the eye. Sides of neck strongly plicate; no dorso-lateral fold. Gular scales smaller than ventrals, smooth. Body much depressed, covered with very small uniform feebly keeled scales smallest on the sides; a slight ridge along the middle of the back; ventral scales smooth. Limbs and digits rather short, the adpressed hind-limb reaching the tympanum or between the latter and the orbit; scales on upper surface of limbs small, equal, keeled. A series of thirty-two to forty-five pores extending along the whole length of the thighs, continuous or interrupted on the præanal region. Tail round, a little depressed at the base, not twice as long as head and body, covered with equal, feebly keeled scales. *Colour.*—Grey-brown above, with small darker and lighter spots; a series of transverse black spots on the back separated or connected by a black vertebral line; throat and chest mottled with blackish."—Boulenger.

Total length	...	...	150	mm.
Head ...	...	...	15	,,
Width of head	...	...	13	,,
Body ...	...	...	42	,,
Fore-limb ...	...	...	23	,,
Hind-limb ...	...	...	42	,,
Tail ...	...	...	93	,,

Habits.—A single female specimen of this lizard was obtained by Mr. F. M. Reader, of Dimboola. On dissection, the oviduct was found to contain three eggs, in none of which was there any trace of an embryo.

Distribution.—Victoria: Dimboola.

Range outside Victoria.—South and West Australia.

AMPHIBOLURUS ANGULIFER, Gray.

Grammatophora angulifera, var. 1, Gray, Cat., p. 252.

Grammatophora muricata, var. *diemensis*, Gray, Grey's Trav. Austr. ii., p. 439.

Agama cœlaticeps, Smith, Ill. S. Afr. Rept., pl. lxxiv.

Grammatophora angulifera, Gray, Zool. Erebus and Terror, pl. xviii., fig. 3.

Description—" Habit stout. Head short, snout as long as the diameter of the orbit; nostril equally distant from the eye and the tip of the snout, tympanum measuring nearly half the diameter of the orbit, upper head-scales rough, strongly keeled. Sides of neck strongly plicate and studded with small spines; a distinct dorso-lateral fold. Gular scales a little smaller than ventrals, keeled. Body much depressed, covered above with very irregular strongly keeled scales intermixed with enlarged spinose ones; the latter form a zig-zag series on each side of the vertebral region, the scales of which are not enlarged, and a longitudinal series following the dorso-lateral fold; they are irregularly scattered on the flanks; ventral scales strongly keeled and mucronate. Limbs and digits short; the adpressed hind-limb reaches the tympanum or between the latter and the orbit; spinose scales scattered on the limbs. Femoral pores four to six on each side, not extending beyond the basal half of the thighs; præanal pores two to five on each side. Tail round, depressed at the base, once and two-thirds to once and three-fourths as long as head and body, above with five longitudinal series of strongly enlarged spinose scales. *Colour.*—Brown above, sides darker; a festooned dark-brown, black-edged band along the back; lower surfaces pale-brown, usually dotted or reticulated with darker.

Total length	...	...	199	mm.
Head ...	...	...	20	„
Width of head ...		...	17	„
Body ...	...	..	56	„
Fore-limb	...	...	32	„
Hind-limb	...	...	47	„
Tail ...	...	...	123	„ "—Boulenger.

Habits.—Met with amongst rocks at considerable elevations in the mountains.

Distribution.—Victoria: Mount Wellington in N. Gippsland, Walhalla, Harrietville in Australian Alps (L. and F.).

Range outside Victoria.—Tasmania, Sydney, Port Denison (Brit. Mus.); Mt. Lofty, South Australia.

AMPHIBOLURUS MURICATUS, White.

Grammatophora muricata, Gray, Cat., p. 251.

Lacerta muricata, White, Journ. N. S. Wales, App., p. 244, pl. xxxi., fig. 1; Shaw, Zool. iii, p. 211, pl. lxv., fig. 2.

Agama muricata, Daud, Rept. iii., p. 391.

Agama jacksoniensis, Kuhl, Beitr. Zool. Vergl. Anat., p. 113; Guérin, Icon. R. A. Rept., pl. iii.

Grammatophora muricata, Kaup, Isis, 1827, p. 261; Dum. and Bibr. iv., p. 475; McCoy, Prodr. Zool. Vict., pl. 111.

Amphibolurus muricatus, Wiegm. Herp. Mex., p. 17; Girard, U. S. Expl. Exp. Herp., p. 414.

Amphibolurus maculiferus, Girard, Proc. Ac. Philad., 1857, p. 198, and U. S. Expl. Exp. Herp., p. 417.

Description.—"Habit moderate. Head rather elongate, snout longer than the diameter of the orbit; canthus rostralis angular; nostril equally distant from the eye and the end of the snout; tympanum measuring nearly half the diameter of the orbit; upper head scales strongly keeled; back of head and borders of the tympanum with small spines. Sides of neck strongly plicate; a more or less distinct dorso-lateral fold frequently disappearing altogether in the adult. Gular scales a little smaller than ventrals, feebly keeled. Body moderately depressed, covered above with very irregular small keeled scales intermixed with some very numerous, enlarged, strongly keeled, spinose scales, some of which form regular series along the back; a low serrated vertebral ridge or crest; ventral scales feebly keeled, shortly mucronate. Limbs moderately elongate, the adpressed hind-limb reaching the eye or between the latter and the tympanum; limbs with strongly keeled scales of unequal size. Femoral pores three or four on each side, not extending beyond the proximal half of the thigh, præanal pores two on each side. Tail round, twice or more than twice as long as head and body, covered above with strongly keeled scales of unequal size. *Colour.*—Brown above, with

a series of angular darker spots along the middle of the back; sometimes a lighter band along each side of the latter; lower surfaces lighter brown, uniform or indistinctly spotted with darker.

Total length	307	mm.
Head	29	„
Width of head	24	„
Body	73	„
Fore-limb	41	„
Hind-limb	76	„
Tail	205	„ "—Boulenger.

Habits.—Usually met with on the trunks or branches of trees and shrubs. In colour closely resembles the bark. Very common in the sandy districts on the south coast, especially on the Leptospermum scrub. "It is fond of basking in the sun on sandy paths . . . . In confinement feeds readily on flies."—"The eggs are laid in the sand."—(McCoy).

Distribution.—Victoria: Melbourne, Caulfield, Plenty River, Upper Yarra, Damper Creek, Gippsland, Goulburn River, Stawell (Melb. Mus.); Drysdale, Tallarook, Rutherglen (L. and F.).

Range outside Victoria.—Western Australia, Tasmania, Sydney (Brit. Mus.).

AMPHIBOLURUS BARBATUS, Cuvier.

Grammatophora barbata, Gray, Cat., p. 252.

Agama barbata, Cuv. R. A. 2nd ed. ii., p. 35; Duvern. R. A., Rept., pl. xiv., fig. 1.

Grammatophora barbata, Kaup. Isis, 1827, p. 621; Dum. and Bibr. iv., p. 478; Gray, Zool. Erebus and Terror Rept., pl. xviii., fig. 1; McCoy, Prodr. Zool. Vict., pl. 121.

Amphibolurus barbatus, Wieg. Herp. Mex., p. 7.

Description.—"Habit stout. Head large, swollen at the sides; snout a little longer than the diameter of the orbit, with angular canthus rostralis; nostril large, directed backwards, nearly equally distant from the eye and the end of the snout; tympanum nearly half the diameter of the orbit; upper head-scales keeled, largest on the snout; a transverse series of larger scales borders the head posteriorly, forming a right angle

with another series above the ear. Sides of neck with group of spines; no distinct dorso-lateral fold. Gular scales as large as ventrals, feebly keeled, more or less mucronate, sometimes produced into spines. Body much depressed; scales on the middle of the back largest, unequal, keeled, the enlarged ones sometimes forming transverse series; on the sides, the scales almost granular and intermixed with numerous erect conical spines; ventral scales feebly keeled. Limbs, and especially digits, short; the adpressed hind-limb reaches the axilla or the shoulder; four or five femoral and two or three præanal pores on each side. Tail round, depressed at the base, once and a half to twice as long as head and body, above with large unequal strongly keeled or spinose scales forming more or less regular cross series. *Colour.*—Brown above, uniform or with symmetrical darker markings; usually a black spot on each side of the neck; lower surfaces brown or brownish, uniform or with lighter or darker spots; the throat blackish in the adult male.

Total length	530	mm.
Head	67	,,
Width of head	65	,,
Body	163	,,
Fore-limb...	92	,,
Hind-limb	123	,,
Tail	300	,, "—Boulenger.

Habits.—Usually found on the ground, or fallen trees and fences. When irritated, it raises its head, opens its mouth and extends the frill, at the same time expanding its ribs so that the body assumes almost the form of a disk. It will then bite savagely, but the result is rarely more than a hard pinch.

Mode of reproduction.—Eggs usually twelve or fourteen. The oviduct of one captured in October contained fourteen full-size eggs with definite groups of two other sizes, one the size of small peas and the other about the size of millet seed. This seems to point to three consecutive layings.

Distribution.—Victoria: "Rare near Melbourne but becomes gradually more abundant in all the more northern warm localities up to the Murray boundary" (McCoy, Prod. Zool. Vict.); North of the Divide (L. and F.)

Range outside Victoria: New South Wales, Queensland, West and North West Australia.

TYMPANOCRYPTIS, Peters.

Tympanum hidden. Body depressed, covered above with heterogeneous scales. No dorsal crest. No gular sac; a strong transverse gular fold. Tail round. A præanal pore on each side, sometimes absent in the female; no femoral pores.

Australia.

TYMPANOCRYPTIS LINEATA, Peters.

Tympanocryptis lineata, Peters, Mon. Berl. Ac., 1863, p. 230; McCoy, Prodr. Zool. Vict., pl. 181.

Description.—" Habit very stout. Head short; nostril nearer to the eye than the tip of the snout; upper head-scales moderately large, very strongly keeled, with slightly enlarged ones on the occiput. Dorsal scales very strongly keeled, the enlarged ones nail-shaped, raised, not or scarcely mucronate; gular and ventral scales indistinctly keeled. The adpressed hind-limb reaches the shoulder or the neck. Tail rather slender, covered with very strongly keeled scales, not more than once and a half the length of head and body. *Colour.*—Brownish above, with regular darker transverse spots, and five interrupted longitudinal light lines, three on the back and one on each side; limbs and tail with dark bars.

Total length	122 mm.	
Head	15 ,,	
Width of head	14 ,,	
Body	43 ,,	
Fore-limb...	23 ,,	
Hind-limb	33 ,,	
Tail	64 ,,	"—Boulenger.

Habits.—" Inhabiting stony plains and retreating into small holes, like those of the 'Trap-door Spider,' in the ground when alarmed." (McCoy, l.c.) Often met with under loose basalt boulders.

Distribution. — Victoria: Salt-water River, Maryborough, Rutherglen (F. and L.); Sunbury (McCoy).

Range outside Victoria. — South Australia: Kangaroo I. *(Brit. Mus.)*

PHYSIGNATHUS, Cuvier.

Tympanum distinct. Body more or less compressed. Nuchal and dorsal crests present. No gular sac, a strong transverse gular fold. Tail more or less compressed. Toes not lobate. Femoral pores present, at least in the male.

Australia and Papuasia ; Siam and Cochin China.

PHYSIGNATHUS LESUEURII, Gray.

Physignathus lesueurii, Gray, Cat., p. 248.

Lophura lesueurii, Gray, Griff., A. K., ix., Syn., p. 60.

Istiurus lesueurii, Dum. and Bibr., p. 384, pl. xl.

Amphibolurus heterurus, Peters, Mon. Berl. Ac., 1866, p. 86.

Physignathus lesueurii, Günth., Ann. Mag. N.H. (3) xx., 1867, p. 51.

Physignathus lesueurii, var. *howittii*, McCoy, Prodr. Zool. Vict., pl. 81.

Description.—" Head moderately elongate, large and thick in the male ; snout slightly longer than the diameter of the orbit ; nostril nearer the end of the snout than the orbit ; canthus rostralis, supraciliary and supraorbital borders forming slight ridges ; tympanum half the diameter of the orbit ; upper head-scales very small, very strongly keeled ; occiput and temple with numerous conical and compressed tubercles. Gular scales subimbricate, indistinctly keeled, intermixed on the sides with enlarged suboval tubercles forming irregular longitudinal series ; some of the hindermost of these tubercles conical ; a row of slightly enlarged shields on each side, parallel with the infralabials. Nuchal crest composed of a few triangular compressed spines ; dorsal crest a serrated ridge. Dorsal scales minute, granular or subimbricate, keeled, intermixed with enlarged, roundish, keeled tubercles forming irregular transverse series ; ventral scales larger than dorsals, imbricate, keeled. Limbs long, scaled like the back ; the adpressed hind-limb reaches between the eye and the end of the snout. Sixteen to twenty-two femoral pores on each side. Tail strongly compressed, crested like the back, twice and a half times as long as the body ; superolateral scales very small, intermixed at the base of the tail with enlarged

tubercles; lower scales larger. *Colour.*—Dark-olive above, with darker and lighter cross bands; a broad black band from the eye to above the shoulder, involving the tympanum; belly pale-olive, dotted with black; throat with black longitudinal lines in the young."—Boulenger.

Total length	...	...	466 mm.
Head ...	...	...	46 "
Width of head	...	...	39 "
Body ...	...	...	120 "
Fore-limb...	...	...	80 "
Hind-limb	...	...	150 "
Tail ...	...	...	330 "

Habits.—Semi-aquatic; found basking in the sun on rocks and fallen logs at the water-side.

Distribution.—Victoria: Aberfeldie, Buchan, Upper Wellington, and Snowy Rivers.

Range outside Victoria:—Queensland.

VARANIDÆ.

Characters of the Family.

External Form.

Tongue smooth, very long and slender, bifid, retractile into a sheath at the base.

Tail very long, not fragile.

Limbs, both pairs well developed, pentadactyle.

Eye and *Ear.*—Eyelids well developed. Ear-opening distinct.

Teguments.

Head covered with small polygonal scales. No dermal cranial ossifications. Dorsal scales roundish, juxtaposed, surrounded by rings of minute granules. Ventral scales squarish, arranged in cross rows. No femoral or præanal pores. (The skin of the head attached to the skull-bones.)

Endo-skeleton.

Skull.—Præmaxillary single, narrowed and much prolonged posteriorly. Nasal bones coalesced, narrow. Two frontals; a single *parietal.* A supraorbital bone. Postorbital arch incomplete.

A bony postfronto-squamosal arch. Pterygoids and palatines widely separated. Infraorbital fossa bounded by the pterygoid, palatine and transverse bone, the maxillary being excluded.

Teeth large, dilated at the base which is fixed to the inner side of the jaws. Palate toothless.

Limb-arches.—Clavicle slender. Interclavicle anchor-shaped.

Mode of Reproduction.

Oviparous.

VARANUS, Merrem.

The only genus. Characters those of the Family.

VARANUS VARIUS, Shaw.

Hydrosaurus varius, Gray, Cat., p. 12; McCoy, Prodr. Zool. Vict., pl. 41.

Lacerta varia, Shaw in White's Voy. N.S. Wales, p. 246, pl. iii., fig. 2, and Zool. Misc. iii., pl. lxxxiii.

Tupinambis variegatus, Daud., Rept. iii., p. 76.

Varanus varius, Merr. Tent., p. 58; Dum. and Bibr. iii., p. 491.

Hydrosaurus variegatus, Wagl. Syst. Amph., p. 164.

Monitor varius, Gray, Griff. A.K. ix., Syn., p. 25; Schleg. Abbild., p. 78.

Varanus (Hydrosaurus) mustelinus, De Borre, Bull. Ac. Belg. (2), xxix., 1870, p. 125.

Description.—"Teeth acute, compressed. Snout depressed at the end, measuring the distance from the anterior border of the orbit to the ear; canthus rostralis obtuse. Nostril suboval, twice nearer the tip of the snout than the orbit. Digits long. Tail compressed, keeled above. Scales of head small, larger than those on the temples; supraocular scales equal, very small, granular. Scales on upper surfaces small, oval, tectiform. Abdominal scales feebly keeled, in one hundred and twenty to one hundred and thirty transverse series. Caudal scales keeled; the caudal keel with a very low, doubly-toothed crest. *Colour.*—Upper surfaces black, with yellow punctulations arranged in transverse bands on the back and lunate bands on the neck; limbs with large spots or annuli; lower surfaces yellow or greenish, with transverse black bands; tail alternately black and yellow in its posterior half.

Total length	... ...	1480 mm.	
Head	... ...	90 „	
Neck	... ...	130 „	
Body	... ...	330 „	
Fore-limb	... ...	190 „	
Hind-limb	... ...	250 „	
Tail	... ...	930 „	"—Boulenger.

Habits.—" Although the Lace Lizard is generally arboreal, climbing the forest trees with ease, and running well on the ground, it can swim nearly as well as a crocodile."—McCoy, Prodr. Z.V.

" They are very voracious, and eat living or dead animals." The particular food may be the smaller or even larger (if dead) mammals, birds, other lizards, and especially, as the settlers find to their cost, the eggs and young birds of the poultry yard.

" They lay about a dozen large, tough, flexible, white eggs, about two-and-a-half inches long, and one-and-a-half inches wide, the young in which are nine or ten inches long."—McCoy, l.c.

Distribution.—Victoria: In forest country whether in the warm Murray region or in Gippsland and the south; replaced in the Wimmera by *V. Gouldii.*

Localities.—Rutherglen, Beechworth, Walhalla, Moe, Cabbage Tree Creek, Anderson's Inlet (L. and F.).

Range outside Victoria: New South Wales, Queensland (Gayndah) (Brit. Mus.).

VARANUS VARIUS, *var.* bellii.

Hydrosaurus bellii, Gray, Cat., p. 13.

Varanus bellii, Dum. and Bibr., iii., p. 493, pl. xxxv.

" Black, with a few very broad yellowish cross bands, generally black-dotted; belly uniform yellowish."

VARANUS GOULDII, Gray.

Monitor gouldii, Gray, Cat., p. 12.

Hydrosaurus gouldii, Gray, Ann. N.H., i., 1838, p. 394, and in Grey's Travels Austr., ii., p. 422.

Monitor gouldii, Schleg. Abbild., p. 78; Gray, Zool. Erebus and Terror Rept., pl. iii.; Peters and Doria, Ann. Mus. Genov., xiii., 1878, pl. i., fig. 4; McCoy, Prodr. Zool. Vict., pl. 151.

Varanus gouldii, A. Dum., Cat. Méth. Rept., p. 52.

Description.—"Teeth acute, compressed. Snout depressed at the tip, long, the distance from its end to the anterior corner of the eye equalling the distance from the latter point to the anterior border of the ear; canthus rostralis sharp. Nostril round, nearer the tip of the snout than the orbit. Digits strong, moderately elongate. Tail strongly compressed, keeled above. Scales of head, including supraoculars, subequal, very small, not larger than those on the temples. Scales of upper surface of body and limbs small, oval, tectiform. Abdominal scales smooth, in one hundred and twenty-five to one hundred and forty transverse rows. Caudal scales keeled; the caudal keel with a very low doubly-toothed crest. *Colour.*—Brown above with more or less distinct round yellow spots or ocelli on the back and limbs and yellow annuli round the tail; temple with two yellow streaks, separated by a black band; these streaks extending more or less distinctly along the sides of the neck; lower surfaces yellowish, uniform or with small blackish spots. Young with the markings much accentuated.

Total length	... ..	1300	mm.
Head	... ...	80	,,
Neck	... ...	130	,,
Body	... ...	340	,,
Fore-limb...	... ...	200	,,
Hind-limb	...	220	,,
Tail	... ...	750	,, "—Boulenger.

Habits.—"Found only in the north-west part of the colony, in the hot mallee-scrub country, where it is common, far away from water, running swiftly about the herbage, and sheltering in holes in the ground." Hisses loudly if disturbed. "When irritated it inflates the skin of the body, swelling to a considerably greater size than before, and then the wrinkles disappear."

Distribution. — Victoria: Wimmera (McCoy), Rutherglen (L. and F.).

Range outside Victoria: W. Australia, N.W. Australia, Dirk Hartog I., Thursday I., Port Essington, Gayndah (Queensland), (Brit. Mus.).

SCINCIDÆ.

Characters of the Family.

External Form.

Head slightly depressed; body more or less round. Tongue moderately long, free, and feebly nicked in front; covered with imbricate scale-like papillæ.

Tail usually long, cylindrical, covered with scales similar to those on the body, rather fragile, slowly reproduced.

Limbs very various, from well-developed to rudimentary.

Eye and *Ear.*—Eye moderately large, pupil round, eyelids usually well developed, movable—except in *Ablepharus*—scaly or with a transparent disk. Tympanum, usually more or less exposed.

Teguments.

Skin covered with cycloid-hexagonal rarely rhomboidal imbricate scales, which may be either smooth or keeled, dorsals usually the largest, and laterals smallest. Head covered with symmetrical shields. No femoral pores.

Endo-skeleton.

Skull slightly depressed, præmaxillary bones two, sometimes incompletely separated; nasal double; frontal single or double; parietal single; postorbital and postfronto-temporal arches complete, osseous; interorbital septum and columella cranii well-developed; infraorbital fossa present, bounded by the maxillary, the transverse bone, the palatine, and often also by the pterygoid. Skull with bony dermal plates over-roofing the supratemporal fossa.

Dentition pleurodont; the teeth conical, bicuspid, or with sphæroidal or compressed crowns; the new teeth hollow out the base of the old ones. Pterygoid teeth may be present.

Vertebræ.

Limb-arches.—Pectoral and pelvic arches constantly present. Clavicle dilated and usually perforated proximally; interclavicle cruciform. Ossified abdominal ribs are absent.

Mode of reproduction.

Oviparous or viviparous; eggs oval, shell membranous, flexible.

EGERNIA, Gray.

Palatine bones not meeting on the middle line of the palate. Pterygoid teeth few or absent. Lateral teeth with compressed obtusely tricuspid crowns. Eyelids well developed, scaly. Tympanum distinct, deeply sunk. Nostril pierced in the nasal which may be divided by a vertical groove; no supranasals; præfrontals well developed; frontoparietals and interparietal distinct. Limbs well developed, pentadactyle; digits cylindrical or compressed, with transverse lamellæ inferiorly.

This genus, which is confined to Australia, is represented by nine species, three of which occur in Victoria.

EGERNIA WHITII, Lacép.

Hinulia whitei, Gray, Cat., p. 79; McCoy, Prodr. Zool. Vic., pl. 191.

Scincus whitii, Lacép., Ann. Mus., iv., p. 192; Quoy and Gaim., Voy. Uranie, Zool., pl. xlii., figs. 2 and 3.

Tiliqua leucopsis, Gray, Ann. N. H., ii., 1838, p. 291.

Lygosoma molinigera, Dum. and Bibr. v., p. 736.

Lygosoma whitei, Peters, Mon. Berl. Ac., 1863, p. 230.

Euprepes whitei, Steindachn, Novara, Rept., p. 49.

Description.—"Head moderate. Curved groove behind the nostril absent or feebly marked; a vertical suture below the nostril; frontonasal in contact with the rostral and frequently also with the frontal; prefrontals sometimes forming a median suture; frontal not twice as long as broad, as long as or a little longer than the frontoparietal; four or five supraoculars, second largest; eight or ten supracilliaries; fifth and sixth, or sixth and seventh upper labials below the eye; three large temporals; one or two pairs of nuchals. Ear-opening nearly as large as the eye-opening, with three or four obtuse lobules anteriorly. Scales

smooth, laterals a little smaller than the dorsals and ventrals, thirty-two to forty round the middle of the body. The adpressed limbs overlap. Digits moderately elongate. Tail more or less distinctly compressed, once and two-fifths to once and two-thirds the length of head and body; caudal scales smooth. *Colour.*—Upper surfaces usually brown or olive-brown, with two dorsal black bands, each bearing a series of yellowish-white or pale-brown spots; sides with similar black-edged spots or ocelli; lower surfaces pale-olive, throat sometimes with black markings." —Boulenger.

In hilly country specimens are after met with on which the markings of the upper surfaces have entirely disappeared. The edge of the eyelids and ear lobules are constantly yellow.

Total length	... ...	295 mm.
Head	... ...	25 ,,
Width of head	... ...	18 ,,
Body	... ...	85 ,,
Fore-limb	... ...	33 ,,
Hind-limb	... ...	48 ,,
Tail	... ...	185 ,,

In Victoria this lizard rarely exceeds 250 mm. in length.

Habits.—This lizard is usually met with on open stony ground, and dry rocky hills. When disturbed it rapidly disappears under logs or stones. In confinement it makes an interesting little pet, soon becoming tame and readily taking insects from the hand. Its food consists chiefly of insects, although in captivity it will feed on smaller lizards, and in one instance within our knowledge one was known to swallow its own tail.

Distribution. — Victoria: Mordialloc, Caulfield, Sunbury, Keilor, Upper Yarra, Jan Juc, Mt. Hope, Grampians, Beaufort (Melb. Mus.). This species is distributed over the whole of the colony (L. and F.).

Range outside Victoria: South Australia, West Australia, Houtman's Abrolhos, Tasmania, King Island, Kent Group, Kangaroo Island, New South Wales, Queensland.

EGERNIA STRIOLATA, Peters.

Tropidolepisma striolatum, Peters, Mon. Berl. Ac., p. 642.

Description.—"Head moderate. A curved groove behind the nostril; frontonasal in contact with the rostral; præfrontals forming a median suture; frontal not twice as long as broad, as large as or smaller than the interparietal; four supraoculars, second largest; seven supraciliaries; fifth or sixth upper labial entering the orbit; two or three pairs of nuchals. Ear-opening as large as the eye-opening, with three pointed lobules anteriorly. Twenty-eight to thirty-two scales round the middle of the body; dorsals largest, quadri- or quinquecarinate, laterals smallest, tricarinate. The adpressed limbs overlap. Digits moderate. Tail cylindrical, a little longer than the head and body; a series of large, transversely dilated scales on the upper as well as the lower surface of the tail, the former pluricarinate. *Colour.*—Brown above with lighter dots and a lighter dorso-lateral band; longitudinal, more or less confluent blackish streaks on the vertebral region; a blackish lateral band; upper head-shields black edged; labials yellowish, black-edged; lower surfaces yellowish or greyish; throat spotted or reticulated with blackish."

The above colouring applies to specimens from the northern parts of the colony, but on the rocky hills and mountains further south, the colour is uniform blackish-brown or with light dots. The upper labials constantly greyish-white.

Total length	...	...	190	mm.
Head ...	...	...	21	„
Width of Head ...		...	15	„
Body ...	...	...	69	„
Fore-limb	...	...	27	„
Hind-limb	...	...	36	„
Tail ...	...	...	100	„

Habits.—This lizard is usually found amongst the rocks on hills and mountains.

Mode of reproduction.—Young developed within the body of the parent, three or four being brought forth at a time.

Distribution.—Victoria: Gunbower, Pyramid Hill, Upper Yarra, Lilydale, Gippsland (Melb. Mus.); Dimboola, Croajin-

golong, Grampians, Pyramid Hill, Gembrook, Tynong (L. and F.).

Range outside Victoria.—Northern Queensland, Gayndah.

EGERNIA CUNNINGHAMI, Gray.

Egernia cunninghami, Gray, Cat., p. 105.

Tiliqua cunninghami, Gray, Proc. Zool. Soc., 1832, p. 40.

Egernia cunninghami, Gray, Ann. N.H., ii., 1838, p. 288, and in Stokes, Discov. in Austral., i., p. 499, pl. ii.

Tropidolepisma cunninghami, A. Dum., Cat. Méth. Rept., p. 177.

Egernia krefftii, Peters, Mon. Berl. Ac., 1871, p. 30.

Description.—"Head moderate. A curved groove behind the nostril; frontonasal in contact with the rostral; præfrontals usually forming a median suture; frontal not twice as long as broad, as large as or a little larger than the interparietal; four or five supraoculars, second largest; seven or eight superciliaries; sixth and seventh, or seventh and eighth upper labials entering the orbit; two or four pair of nuchals. Ear-opening as large as, or a little larger than the eye-opening, with four or five pointed lobules anteriorly. Nuchal scales pluricarinate, dorsals and laterals sharply unicarinate, ending in a point, the keel and the point becoming stronger towards the tail; dorsal scales largest, laterals smallest; thirty-six to forty-two scales round the middle of the body. The adpressed limbs largely overlap. Digits moderate. Tail cylindrical, a little longer than the head and body; upper caudal scales strongly unicarinate, ending in a spine."

Colour.—Olive-brown above with irregular spots or blotches of a darker colour; in the young speckled with light dots, which usually disappear in the adult; head-shields edged with black; lower surfaces whitish or pale-olive spotted or blotched with dark-brown; throat whitish-olive.

Total length	...	...	330	mm.
Head ...	...	...	35	„
Width of head	...	...	25	„
Body ...	...	...	115	„
Fore-limb ...	...	...	46	„
Hind-limb	...	...	62	„
Tail ...	...	...	180	„

Habits.—Found in rocky places.

Distribution. — Victoria: Melbourne, Sunbury, Brighton, Castlemaine, Beechworth, Mt. Stanley.

Range outside Victoria.—West Australia, Sydney, Queensland.

TRACHYSAURUS, Gray.

Palatine bones in contact on the middle line of the palate. Pterygoids toothless. Lateral teeth with subconical crowns. Eyelids well developed, scaly. Tympanum distinct, deeply sunk. Nostril pierced in a single nasal, with a curved groove behind; no supranasals; a complete series of shields between the orbit and the upper labials; præfrontals well developed; fronto-parietals and interparietal distinct, the latter shield in contact with an azygos occipital. Dorsal scales rhomboidal, rugose. Limbs short, pentadactyle; digits cylindrical; subdigital lamellæ mostly divided. Tail short, stump-like.

This genus, which is represented by only one species, extends over the whole of Australia to which it is confined.

TRACHYSAURUS RUGOSUS, Gray.

Trachydosaurus rugosus, Gray, Cat., p. 102.

——— *asper*, Gray, l.c., p. 103.

Trachysaurus rugosus, Gray, in King's Voy. Austral., ii., p. 430, Dum. and Bibr., v., p. 754; McCoy, Prodr. Zool. Vict., dec. xi., pl. 102; Haake, Zool. Anz., 1885, p. 435.

——— *peronii*, Wagl., Icon. Amph. (nec fig.)

Brachydactylus typicus, Smith, S. Afr. Quart. Journ., ii., 1835, p. 144, pl.—

Trachysaurus typicus, Gray, in Grey's Journ. Austral., ii., p. 423.

——— *asper*, A. Dum., Cat. Méth. Rept., p. 179.

Description.—" Head large, very distinct from neck; snout short, obtuse. Head-shields convex, more or less rugose. Fronto-nasal the largest head-shield; præfrontals forming a median suture; two or three supraoculars and five to seven supraciliaries; frontal and interparietal varying much in length; ear-opening about as large as the eye-opening, without lobules. Dorsal scales very large, rough, strongly imbricate, suggestive of the fruit of a pine; ventrals much smaller, smooth; twenty to thirty scales

round the middle of the body. Limbs widely separated when adpressed; digits very short. Tail about as long as the head, stump-like, scaled like the body. *Colour.*—Dark-brown above, with yellowish spots or irregular cross-bands; lower surfaces yellowish, spotted or marbled with brown, or with longitudinal and transverse brown streaks.

Total length	...	...	353	mm.	
Head ...	..	...	60	„	
Width of head	...	...	58	„	
Body ...	...	...	230	„	
Fore-limb...	...	...	56	„	
Hind-limb	...	...	57	„	
Tail ...	...	...	63	„	"—Boulenger.

Habits.—Found in dry open country; movements very sluggish.

This lizard appears to subsist on a vegetable diet, the stomach of one found on the Grampians contained nothing but fungus and *Styphelia* berries.

Mode of reproduction.—Young developed within the body of the parent. "Brings forth in March a single young one of surprising size, about half the length of the parent."—McCoy, Prod. Zool. of Vict.

Distribution.—Victoria: Kewell, (Melb. Mus.).; Northern parts of the Colony, (McCoy); Grampians, Wimmera (L. and F.).

TILIQUA, Gray.

Palatine bones in contact on the middle line of the palate. Pterygoids toothless. Lateral teeth with spheroidal crowns.* Eyelids well developed, scaly. Tympanum distinct, deeply sunk. Nostril pierced in a single nasal, with a curved groove behind; no supranasals; a complete series of shields between the orbit and the upper labials; præfrontals well developed; frontoparietals and interparietal distinct. Limbs short, pentadactyle; digits subcylindrical or slightly compressed with undivided transverse lamellæ inferiorly.

The genus contains five species which range over Australasia, from Tasmania to the Indo-Malayan Islands. Three of the species occur in Victoria.

* Except in *T. adelaidensis*, which has the teeth more conical.

TILIQUA SCINCOIDES, White.

Cyclodus gigas, Gray, Cat., p. 103.

Lacerta scincoides, White Jour., Voy. N.S. Wales, p. 242, pl.—; Shaw, Nat. Miscell., v., pl. clxxix.

Scincus crotaphomelas, Lacép., Ann. Mus., iv., 1804, pp. 192, 209.

——— *tuberculatus*, Merr. Tent., p. 73.

Tiliqua tuberculata, Gray, Ann. Phil. (2) x., 1825, p. 201, and in Gray's Voy. Austr. ii., p. 429.

——— *scincoides*, Fitzing, N. Class Rept., p. 52.

——— *whitii*, Gray, Griff. A.K., ix., Syn., p. 67.

——— *crotaphomelas*, Gray, l.c., p. 68.

Cyclodus boddoertii, part., Dum. and Bibr. v., p. 752.

——— *gigas*, Girard, U.S. Explor. Exped., Herp., p. 233; Strauch, Bull. Ac. St. Pétersb., x., 1866, p. 454; McCoy, Prod. Zool. Vict., dec. viii., pl. lxxi.

——— *boddoertii*, Peters and Doria, Ann. Mus. Genova, xiii., 1878, p. 366.

Description.—"Frontonasal in contact with the rostral; præfrontals forming a median suture; four supraoculars, second largest; six or seven supraciliaries; interparietal narrower than the parietals; scales on the occiput not or but slightly broader than long; anterior temporals much larger than the others, about as long as the interparietal; ear-opening about as large as the eye-opening, with two or three large, obtuse lobules. Scales smooth, laterals a little smaller than the dorsals and ventrals, thirty-four to forty round the middle of the body. Fore-limb as long as or a little shorter than the head; its length in the adult, contained from three to four times in the distance between axilla and groin. Tail cylindrical, shorter than the body." *Colour.*—Olive above with seven or eight more or less distinct dark-brown cross bands; fine dark-brown lines marking the intersection of scales along the upper surface of the neck; usually with a dark-brown band extending from above the fore-limb to the eye, broken above the ear-opening; tail with six or seven dark-brown cross bands; sides and under surfaces greyish, or yellowish, with blackish transverse marblings; throat immaculate or with a few dark spots. Tongue bright Prussian-blue.

Total length	...	...	585 mm.
Head	...	...	70 „
Width of head		...	58 „
Body	...	...	265 „
Fore-limb...	...	...	68 „
Hind-limb	...	...	67 „
Tail	...	...	250 „

Habits.—Met with in sandy heath country, and on the hill sides in lightly timbered districts. Movements very sluggish.

Mode of reproduction.—Oviparous, eggs round, twelve to fifteen laid about December. A female specimen captured in November, on dissection was found to contain fifteen full-size eggs, in none of which was there any trace of an embryo.

Distribution.—Victoria: Sunbury, Pyramid Hill (Melb. Mus.); Kew, Woodend, Werribee Gorge (L. and F.).

Range outside Victoria.—Tasmania, King Island, New South Wales, Port Essington, Cape York.

TILIQUA NIGRO-LUTEA, Gray.

Cyclodus nigroluteus, Gray, Cat., p. 104; Quoy. and Gaim., Voy. Uranie Rept., pl. xli.

Tiliqua nigroluteas, Gray, Griff. A. K., ix., Syn., p. 68.

Cyclodus nigroluteus, Dum. and Bibr., v., p. 750; Strauch, Bull. Ac., St. Petersb., x., 1866, p. 457.

Description.—"Frontonasal in contact with the rostral, and sometimes with the frontal; four supraoculars; four or five supraciliaries; interparietal narrower than the parietals; scales on the occiput not broader than long; anterior temporals not larger than the others; ear-opening smaller than the eye-opening, with two obtuse lobules; twenty-eight to thirty scales round the middle of the body, dorsals largest, rather rugose. Fore-limb as long as or slightly longer than the head, its length contained thrice to thrice and a half in the distance between axilla and groin. Tail not quite half the length of head and body, cylindrical." *Colour.*—Upper surfaces of head and tail olive-brown, body dull-yellow with blackish-brown irregular longitudinal dashes and transverse bands, leaving the ground colour in from five to seven irregular patches extending from the neck to the base of the tail;

tail with from five to seven irregular dark-brown bands; sides and limbs greyish-olive, marbled with dark-brown; under surfaces yellowish; throat immaculate, belly variegated with dark-brown reticulations. Tongue bright Prussian-blue.

Total length	... ...	375 mm.
Head ...	... ...	45 „
Width of head	... ..	35 „
Body ...	... ...	210 „
Fore-limb...	... ...	50 „
Hind-limb	... ...	50 „
Tail ...	... ...	120 „

Habits.—In its habits this lizard is similar to *T. scincoides* but is much more active; when irritated it opens its mouth and snaps from side to side, at the same time making a sound similar to that made by blowing with a bellows. If allowed to seize one's hand it is some time before it can be made to relax its hold. Its food consists of insects, fungus, and probably the fruit of small shrubs. In confinement it will feed on bread and milk and bits of raw meat.

Mode of reproduction.—Young developed within the body of the parent, twelve or fourteen being brought forth at a time.

Distribution. — Victoria: Ringwood, Mordialloc, Frankston (Melb. Mus.); Oakleigh, Phillip Island, Plenty Ranges, Fernshaw, Grampians (L. and F.).

Range outside Victoria.—South Australia, Tasmania.

TILIQUA OCCIPITALIS, Peters.

Cyclodus occipitalis, Peters, Mon. Berl. Ac., 1863, p. 231; Strauch, Bull. Ac., St. Petersb., x., 1866, p. 456.

Cyclodus fasciatus, Lütken, Vidensk., Meddel., 1862 (1863), p. 292, pl. i., fig. 1; Strauch, l.c.

Description.—"Frontonasal in contact with the rostral and with the frontal; three (or two) supraoculars, first largest; four or five supraciliaries; interparietal narrower than the parietals; scales on the occiput longer than broad; anterior temporals not larger than the others; ear-opening a little larger than the eye-opening with three obtuse lobules. Scales smooth, forty to forty-two round the middle of the body, laterals a little smaller than

the dorsals and ventrals. Fore-limb slightly longer than the head, its length contained twice and a half in the distance between axilla and groin. Tail not quite half the length of head and body, very slightly compressed." *Colour.*—Yellowish above with four or five dark-brown bands across the body, and three or four others encircling the tail, a broad dark-brown band from the eye to above the ear, limbs and under surfaces yellowish, the distal part of limbs darker above. Tongue bright Prussian-blue.

Total length	...	...	388 mm.
Head ...	...	...	50 „
Width of head	...	...	34 „
Body ..	...	...	204 „
Fore-limb...	...	...	52 „
Hind-limb	...	...	54 „
Tail ...	...	...	134 „

Distribution.—Victoria: Western district (Melb. Mus.) Range outside Victoria.—South Australia, Swan River.

LYGOSOMA, Fitzing.

Palatine bones in contact mesially; pterygoid bones usually also in contact anteriorly, the palatal notch not extending forwards to between the centre of the eyes; pterygoid teeth minute or absent. Maxillary teeth conical or obtuse. Eyelids well developed. Ear distinct or hidden; if distinct, tympanum more or less sunk. Nostril pierced in the nasal; supranasals present or absent. Limbs more or less developed, rudimentary, or absent.

There are already over 150 known species belonging to this genus, which extends over the whole of Australia, East Indies, China, North and Central America, Tropical and South Africa.

LYGOSOMA.

Sub-genus HINULIA, Gray.

Limbs well-developed, pentadactyle; length of the hind-limb exceeds the distance between the centre of the eye and the fore-limb. Lower eyelid scaly. Tympanum distinct. No supra-

nasals. Frontal not broader than the supraocular region. Frontoparietals distinct. A pair of enlarged præanals.

HINULIA LESUEURII, Dum. and Bibr.

Hinulia australis, Gray, Cat., p. 77.

Tiliqua australis, Gray, Ann. N.H., ii., 1838, p. 291.

Lygosoma lesueurii, Dum. and Bibr., v., p. 733.

——— *australe*, (non Gray), Peters, Mon. Berl. Ac., 1863, p. 231.

——— *schomburgkii*, Peters, l.c.

Euprepes australis, Steindachn, Novara, Rept., p. 49.

Lygosoma (Hinulia) pantherinum, Peters, Mon. Berl. Ac., 1866, p. 89.

Hinulia spaldingi, Macleay, Proc. Linn. Soc. N.S.W., ii., 1877, p. 63.

Description.—"Habit slender; the distance between the end of the snout and the fore-limb is contained once and a half to twice in the distance between axilla and groin; snout moderate, obtuse; loreal region nearly vertical. Lower eyelid scaly. Nostril pierced in a single nasal, no supranasal; no postnasal; rostral usually in contact with the frontonasal; latter broader than long; præfrontals forming a median suture; frontal as long as or a little longer than the frontoparietals and parietals together, in contact with three anterior supraoculars; four supraoculars; eight supraciliaries; first largest; frontoparietals distinct, as long as or shorter than the interparietal; parietals forming a median suture behind the interparietal; two to four pairs of nuchals; fifth and sixth or sixth and seventh upper labials below the eye. Ear-opening oval, about as large as the eye-opening, the anterior border with a fringe of four or five lobules. Twenty-four to thirty-four smooth scales round the body; dorsals, especially the two vertebral series, largest, laterals smallest. Two large præanals. The hind limb reaches the wrist or the elbow of the adpressed fore-limb. Toes long and slender, compressed; subdigital lamellæ feebly unicarinate, twenty-two to twenty-six under the fourth toe. Tail more than twice the length of head and body. *Colour.*—Brown or olive-brown above, with a black, white-edged vertebral band, and a white, black-edged dorso-

lateral streak; sides blackish, with regular series of white spots; a white streak from above axilla to groin. The ground colour may be black, with the usual white markings. Lower surfaces white.

Total length	... ...	275 mm.
Head ...	... ...	16 „
Width of head	... ...	10 „
Body ...	... ...	69 „
Fore-limb	... ...	24 „
Hind-limb	... ...	40 „
Tail ...	... ...	190 „ ”—Boulenger.

Habits.—This lizard is usually found hidden under logs and stones, where it often forms channels in the soft ground.

Distribution.—Victoria: Prahran, Sunbury, Pyramid Hill (Melb. Mus.); Grampians, Bendigo, Brown's Plains, Castlemaine, Beechworth, Mount Stanley (L. and F.).

Range outside Victoria.—Fairly well distributed over the whole of Australia and adjacent islands.

HINULIA TÆNIOLATA, White.

Hinulia tæniolata, Gray, Cat., p. 78.

Lacerta tæniolata, White, Journ. N.S.W., p. 245, pl.—; fig. 1.

Scincus actolineatus, Daud., Rept., iv., p. 285.

——— *tæniolatus*, Merr. Tent., p. 72.

——— *undecimstriatus*, Kuhl, Beitr. z. Zool. u. Vergl. Anat., p. 129.

——— *multilineatus*, Lesson, Voy. Coquille, Zool., ii., p. 45, pl. iii., fig. 2.

Tiliqua tæniolata, Gray, Griff. A. K., ix., Syn., p. 68.

Lygosoma tæniolata, Dum. and Bibr., v., p. 733; Hallow, Proc. Ac. Philad., 1860, p. 490.

Hinulia tæniolata, Girard, U.S. Explor. Exped., Herp. p. 258.

Euprepes tæniolata, Steindachn. Novara, Rept., p. 49.

Description.—“Habit slender; the distance between the end of the snout and the fore-limb is contained once and a half to once and four-fifths in the distance between axilla and groin. Snout moderate, obtuse; loreal region nearly vertical. Lower *eyelid scaly*. Nostril pierced in a single nasal; no supranasal;

no postnasal; rostral sometimes in contact with the frontonasal; latter broader than long, forming a suture with the frontal; frontal as long as or a little longer than the frontoparietals and parietals together, in contact with the three anterior supraoculars; four supraoculars; seven to nine supraciliaries, first largest; frontoparietals distinct, as long as or shorter than the interparietal; parietals forming a suture behind the interparietal; three to five pairs of nuchals; fifth and sixth upper labials largest and below the eye. Ear-opening oval, a little smaller than the eye-opening, with a fringe formed by three to five lobules anteriorly. Twenty-four to twenty-six smooth scales round the middle of the body; dorsals, especially the two vertebral series, largest, laterals smallest. Two large præanals. The adpressed limbs slightly overlap, or the hind limb reaches the elbow. Toes long and slender, compressed; sub-digital lamellæ feebly unicarinate, twenty to twenty-six under the fourth toe. Tail about twice the length of head and body. *Colour.*—Yellowish-brown above, with three broad black bands and four white streaks along the back; sides without any spots, with alternating black and white longitudinal streaks; altogether eight white streaks on the body, the two on each side broadest; limbs with longitudinal black lines. Lower surfaces white."

Total length	... ...	230	mm.	
Head	... ...	14	"	
Width of head	... ...	9	"	
Body	... ...	61	"	
Fore-limb	... ...	19	"	
Hind-limb	... ...	33	"	
Tail	... ...	155	"	"—Boulenger.

Habits.—Movements very quick. Found in open stony districts.

Distribution.—Victoria: A single specimen found at Beechworth.

Range outside Victoria.—Sydney, Parramatta.

Hinulia quoyi, Dum. and Bibr.

Quoy and Gaim., Voy. Uranie, Zool., pl. xlii., fig 1.

Lygosoma quoyii, Dum. and Bibr., v., p. 728.

Hinulia gastrosticta, Günth., Zool. Ereb. and Terr. Rept., p. 11.

Description.—"Body slightly depressed; the distance between the end of the snout and the fore-limb is contained once and one-fourth to once and a half in the distance between axilla and groin. Snout moderate, obtuse. Lower eyelid scaly. Nostril pierced in a single nasal; frontonasal broader than long, forming a narrow suture with the rostral; præfrontals forming a median suture or in contact with their inner angles; frontal as long as frontoparietals and interparietal together, in contact with the two or three anterior supraoculars; four supraoculars, usually followed by a very small fifth; nine supraciliaries; fronto-parietals and interparietal distinct, equal, or latter a little shorter than former; parietals forming a suture behind the interparietal; three enlarged shields on each side, bordering the parietals; sixth upper labial largest and below the eye. Ear-opening oval, nearly as large as the eye-opening; no auricular lobules. Thirty-six to forty scales round the middle of the body; ventrals largest, laterals smallest; dorsal scales smooth or tricarinate (young). A pair of large præanals. The hind-limb reaches the wrist or the elbow. Digits slightly compressed; subdigital lamellæ smooth, divided, twenty-seven to thirty-two under the fourth toe. Tail about twice as long as head and body. *Colour.*—Brown or olive-brown above, with small scattered black spots; sides black, with small whitish spots; a yellow dorso-lateral line; lower surfaces whitish; throat, and sometimes also belly, with longitudinal series of black dots."

Total length	...	...	285	mm.
Head ...	...	...	24	„
Width of head	...	...	15	„
Body ...	...	...	71	„
Fore-limb	...	...	30	„
Hind-limb	...	...	46	„
Tail ...	...	...	190	„ "—Boulenger.

Habits.—Usually found in open flats and gullies, often in or under hollow logs. In confinement it will feed on flies, termites, worms, caterpillars, and also on smaller lizards.

Whilst on a trip to Noojee recently, where this species is fairly numerous, a female, which appeared to contain ova, was selected and placed in a bag. A few days after, on opening the

bag it was found she had given birth to four young ones. These with the parent were placed in a box containing some earth and flat stones, and covered partly with glass and partly with wire gauze. After a few days the young ones began to take food; they would readily seize anything moving, in the shape of a small grub or caterpillar, but were alarmed at the fluttering of a large moth. When the parent had made a capture the young ones would timidly approach and make a grab at whatever she held in her mouth, but she always seemed disinclined to surrender any portion of it. She showed no anxiety when the young ones were separated from her. Sometimes when trying to capture a fluttering moth, if one of the young ones appeared in front of her she would seize it, but having discovered her mistake, after a few seconds she would drop it unhurt.

What appears to be a remarkable exhibition of intelligence on the part of this lizard occured about this time. A large moth was placed in the cage and was immediately set upon by the lizard which it managed to elude for some time. At length the lizard seized it by the end of the abdomen. The wings being free it continued to flutter in spite of the efforts of the lizard to crush the life out of it by pushing it against the stones; at last she carried it to the end of the cage where there was a dish of water into this she plunged the moth and held it there for about twenty seconds; this completely damped the ardour as well as the wings of the moth, and for a time the fluttering ceased. She then carried it to the top of one of the stones, when the young ones, who had disappeared beneath during the struggle, emerged from their hiding places and timidly approached; presently one of them made a snap at the moth's leg and pulled it off, causing another flutter. The same method of crushing it against the stones and sides of the cage was again tried but without success. Failing in this she carried it to the water a second time, and held it under for about half-a-minute, after which she swallowed it, pushing the wings off in the operation.

Distribution.—Victoria: St. Kilda, Sunbury, Keilor, Upper Yarra, Yarragon, Toora, Gunbower (Melb. Mus.); distributed all over the Colony (L. and F.).

Range outside Victoria.—Kangaroo Island, Rockhampton, Queensland.

LYGOSOMA.

Sub-genus LIOLEPISMA, Dum. and Bibr.

Limbs well developed; the length of the hind-limb exceeds the distance between the centre of the eye and the fore-limb. Lower eyelid with an undivided transparent disk. Tympanum distinct. No supranasals. Rostral forming a suture with the frontonasal. Frontal not broader than the supraocular region. One or more pairs of enlarged nuchals.

LIOLEPISMA MUSTELINUM, O'Shaughn.

Mocoa mustelina, O'Shaugn., Ann. and Mag. N.H. (4), xiii., 1874, p. 299, and (5). iv., 1879, p. 300.

Lygosoma (Mocoa) lacrymans, Peters and Doria, Ann. Mus. Genova, xiii., 1878, p. 348.

——— (——) *sonderi*, Peters, Sitzb. Ges. Nat. Freunde, 1878, p. 191.

——— (——) *orichalceum*, Boettg. Ber. Offenb., Ver. Naturk., xvii.-xviii., 1878, p. 2, pl. i, fig 1.

Description.—" Habit slender, body elongate. The distance between the end of the snout and the fore-limb is contained once and two-thirds to twice in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal, which is quite lateral; no supranasal; frontonasal broader than long, forming a very broad suture with the rostral, and a narrower one with the frontal; latter shield as long as or a little shorter than the frontoparietals and interparietal together, in contact with the two anterior supraoculars; four supraoculars, second largest; six or seven supraciliaries; frontoparietals normally distinct (united in some specimens), as long as or a little longer than the interparietal; parietals forming a suture behind the interparietal, bordered by a pair of nuchals and a pair of temporals; fourth upper labial largest and entering the orbit. Ear-opening oval, not larger than the transparent palpebral disk. Twenty-two to twenty-four smooth scales round the middle of the body; dorsals largest. Præanals not or but feebly enlarged. The adpressed limbs fail to meet. Digits cylindrical; subdigital lamellæ smooth,

sixteen to nineteen under the fourth toe. Tail twice as long as head and body. *Colour.*—Pale brown or yellowish-brown above, golden on the sides and on the tail; each dorsal scale with three or more brown lines; sides usually with interrupted brown longitudinal lines; a white brown edged spot or streak below the posterior border of the eye; lips brown dotted; lower surfaces yellowish-white, sides of throat and belly with fine brown lines or series of dots; two longitudinal lines of confluent brown dots under the tail.

Total length	...	...	135	mm.
Head ...	...	...	10	,,
Width of head	...	...	6	,,
Body ...	...	...	35	,,
Fore-limb	...	...	11	,,
Hind-limb	...	...	16	,,
Tail ...	...	...	90	,, "—Boulenger.

Habits.—This lizard is usually found under logs, and amongst the herbage on the hillsides.

Distribution.—Victoria: St. Kilda, Mulgrave, Dandenong Ranges, Upper Yarra, Waterloo, Lakes Entrance (Melb. Mus.); Ringwood, Ferntree Gully, Healesville, Croajingolong (L. and F.).

Range outside Victoria.—South Australia, New South Wales.

LIOLEPISMA ENTRECASTEAUXII, Dum. and Bibr.

Mocoa entrecasteauxii, Gray, Cat., p. 82.

Lygosoma entrecasteauxii, Dum. and Bibr., v., p. 717.

Mocoa pseudocarinata, O'Shaughn., Ann. Mag. N.H. (4), xiii., 1874, p. 300.

——— *pseudotropis*, Günth., Zool. Ereb. and Terr. Rept., p. 13.

Description.—"The distance between the end of the snout and the fore-limb is contained once and two-fifths to once and three-fourths in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with a very large transparent disk, nearly the whole of the eye being visible when the lid is closed. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, forming a suture with the rostral and with the

frontal; latter shield as long as or a little shorter than frontoparietals and interparietal together, in contact with the first and second supraoculars; four supraoculars, second largest; five or six supraciliaries; frontoparietals distinct, longer than the interparietal; parietals forming a suture behind the interparietal; two or three pairs of nuchals; fifth, rarely sixth, upper labial largest and entering the orbit. Ear-opening roundish, smaller than the transparent palpebral disk, without distinct lobules. Twenty-eight to thirty-two scales round the middle of the body; dorsals largest and usually more or less distinctly striated or obtusely pluricarinate. Præanals not or scarcely enlarged. The adpressed limbs usually meet or overlap. Digits cylindrical; subdigital lamellæ smooth, seventeen to twenty under the fourth toe. Tail once and one-third to once and two-thirds the length of head and body." *Colour.*—Olive above, with three black longitudinal bands, laterals broadest and edged above and below by a light streak; in some specimens both bands and streaks are absent, in which case the ground colour is much lighter and more or less spotted with dark brown or black. Lower surfaces greyish or greenish, sometimes dull reddish-orange.

Total length	... ...	124 mm.
Head ...	... ...	10 „
Width of head	... ...	7 „
Body ...	... ...	41 „
Fore-limb	... ...	14 „
Hind-limb	... ...	18 „
Tail ...	... ...	73 „

Habits.—Usually met with amongst the grass and herbage in open scrubby districts. Movements very quick.

Mode of reproduction—Oviparous, eggs oval, three to five laid in January.

Distribution.—Victoria: Melbourne (Melb. Mus.); Sandringham, Carrum, Tynong, Mt. Baw Baw (L. and F.).

Range outside Victoria.—Tasmania.

LIOLEPISMA TRILINEATUM, Gray.

Mocoa trilineata, part., Gray, Cat., p. 81.

Tiliqua trilineata, Gray, Ann. N.H., ii., 1838, p. 291.

Lygosoma duperreyi, Dum. and Bibr., v., p. 715; A. Dum., Cat. Méth. Rept., p. 167.

Euprepes duperreyi, Steind. Novara, Rept., p. 47.

Description.—" Body much elongate; the distance between the end of the snout and the fore-limb is contained once and a half to twice and a half in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal forming a suture with the rostral, the width of which suture is considerably less than the width of the frontal, and a narrower one with the frontal; latter shield as long as, or shorter than, the frontoparietal, in contact with the two anterior supraoculars; four supraoculars, second largest; five or six supraciliaries; frontoparietal single (rarely divided); a very small interparietal, behind which the parietals form a suture; a pair of nuchals and a pair of temporals border the parietals; fifth upper labial largest and entering the orbit. Ear-opening oval, about as large as the transparent palpebral disk, without or with one or two obtuse lobules. Twenty-six or twenty-eight scales round the middle of the body; dorsals largest and sometimes feebly striated. Præanals not or scarcely enlarged. The adpressed limbs usually fail to meet. Digits cylindrical; subdigital lamellæ smooth, nineteen to twenty-three under the fourth toe. Tail once and one-third to once and three-fourths the length of head and body. *Colour.*—Bronzy-olive above, with a black, light-edged lateral band; frequently the light lateral streaks are again edged with black, and a vertebral black streak is present; lower surfaces grayish or greenish white.

Total length	...	...	173	mm.	
Head ...	...	...	12	„	
Width of head	...	...	8	„	
Body ...	...	...	51	„	
Fore-limb	...	...	15	„	
Hind-limb	...	...	23	„	
Tail ...	...	...	110	„	"—Boulenger.

Habits.—Habits similar to *L. entrecasteauxii*, to which it is very closely allied.

Distribution.—Victoria: Melbourne, Ringwood, Keilor, Brandy Creek, Western Port, Western District (Melb. Mus.); Melbourne, Kew, Carrum, Myrniong, Castlemaine, Grampians (L. and F.).

Range outside Victoria.—Kent Group, Tasmania, New South Wales, West Australia.

LIOLEPISMA METALLICUM, O'Shaughn.

Mocoa ocellata, part., Gray, Cat., p. 82.

Mocoa metallica, O'Shaughn, Ann. and Mag. N.H. (4), xiii., 1874, p. 299.

Description.—"The distance between the end of the snout and the fore-limb is contained once and two-fifths to once and two-thirds in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, forming a suture with the rostral and with the frontal; latter shield shorter than frontoparietal and interparietal together; in contact with the first and second supraoculars; four supraoculars, second largest; six or seven supraciliaries; frontoparietal single (in one specimen divided); interparietal distinct; parietals forming a suture behind the interparietal; a pair of nuchals and a pair of temporals border the parietals; fifth upper labial largest and entering the orbit. Ear-opening roundish, as large as or a little larger than the transparent palpebral disk, without distinct lobules. Twenty-four to twenty-eight scales round the middle of the body; dorsals largest and usually more or less distinctly striated or pluricarinate. Præanals not or but feebly enlarged. The adpressed limbs meet or slightly overlap. Digits cylindrical; subdigital lamellæ smooth eighteen to twenty-two under the fourth toe. Tail about once and a half the length of head and body. *Colour.*—Bronzy-olive above, with small dark-brown spots, sometimes with a dark-brown vertebral streak; sides dark-brown, light-dotted, often with a more or less distinct light streak from ear to groin; lower surfaces greenish or greyish, uniform or with darker dots.

Total length	...	...	133	mm.
Head ...	...	...	11	„
Width of head	...	...	8	„
Body ...	...	...	42	„
Fore-limb	...	...	14	„
Hind-limb	...	...	19	„
Tail ...	...	...	80	„ "—Boulenger.

Habits.—Usually found moving about in open scrub country. Food, insects and worms.

Distribution.—Victoria: Port Albert (Melb. Mus.); Melbourne, Croajingolong (L. and F.).

Range outside Victoria.—Tasmania, Kangaroo Island, Loyalty Islands, New Hebrides.

LIOLEPISMA GUICHENOTI, Dum. and Bibr.

Mocoa guichenoti, Gray, Cat., p. 80.

Mocoa trilineata, part., Gray, l.c., p. 81.

Lygosoma guichenoti, Dum. and Bibr., v., p. 713.

——— *(Mocóa) guttulatum*, Peters, Sitzb. Ges. Naturf. Freunde, 1881, p. 83.

——— (———) *platynotum*, Peters, l.c., p. 84.

Description.—"The distance between the end of the snout and the fore-limb is contained once and one-third to once and two-thirds in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal, which is quite lateral; no supra-nasal; frontonasal forming a broad suture with the rostral, the width of which suture equals the width of the frontal, and a narrower one with the frontal; latter shield narrower and not longer than the frontoparietal, in contact with the two anterior supraoculars; four supraoculars, second largest; seven or eight supraciliaries; frontoparietal single; a small interparietal, behind which the parietals form a suture; a pair of nuchals and a pair of temporals border the parietals; fifth upper labial largest and entering the orbit. Ear-opening oval, about as large as the transparent palpebral disk, without projecting lobules. Twenty-six to thirty scales round the middle of the body; dorsals largest and sometimes feebly striated. Præanals not or but feebly

enlarged. The adpressed limbs overlap, meet, or fail to meet. Digits cylindrical; subdigital lamellæ smooth, twenty to twenty-six under the fourth toe. Tail about once and two-thirds the length of head and body. *Colour.*—Bronzy-olive or brownish above, with or without small darker and lighter spots; vertebral region sometimes darker; a dark-brown lateral band, edged above and below by a light streak; greenish-white inferiorly sometimes with blackish dots.

Total length	...	...	97	mm.
Head ...	...	...	9	"
Width of head	...	...	6	"
Body ...	...	...	31	"
Fore-limb	...	...	11	"
Hind-limb	...	...	15	"
Tail ...	...	...	57	" "—Boulenger.

Habits.—Usually found running about amongst the grass and herbage on dry sandy ground and stony hill sides. Soon becomes tame in captivity and will feed readily on flies, caterpillars, worms, bits of bread and potato.

Mode of reproduction.—Oviparous; eggs oval, three, laid in the ground.

Distribution.—Victoria: Melbourne, Ringwood, Upper Yarra, Mitta Mitta (Melb. Mus.); Kew, Ringwood, Carrum, Loch, Myrniong, Healesville, Beaconsfield, Ferntree Gully, Grampians (L. and F.)

Range outside Victoria.—New South Wales, South Australia, West Australia.

LIOLEPISMA PRETIOSUM, O'Shaughn.

Mocoa pretiosa., O'Shaughn., Ann. and Mag. N.H. (4), xiii., 1874, p. 298.

——— *microlepidota*, O'Shaughn., l.c., p. 299.

Description.—"The distance between the end of the snout and the fore-limb is contained once and two-fifths in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, forming a

suture with the rostral and with the frontal; latter shield a little shorter than frontoparietal and interparietal together, in contact with the two anterior supraoculars; four supraoculars, second largest; seven or eight supraciliaries; frontoparietal single; a small interparietal, behind which the parietals form a suture; a pair of nuchals and a pair of temporals border the parietals; fifth upper labial largest and entering the orbit. Ear-opening oval, larger than the transparent palpebral disk. Thirty-four to thirty-eight scales round the middle of the body; dorsals largest, striated or feebly pluricarinate, præanals not enlarged. The adpressed limbs meet or overlap. Digits cylindrical; subdigital lamellæ smooth, twenty to twenty-two under the fourth toe. Tail a little longer than head and body." *Colour.*—Olive-brown above with small darker and lighter spots, a blackish light dotted lateral band extending from the eye to the groin, often edged above with pale-brown; a blackish vertebral streak may be present; lower surfaces greenish or greyish-salmon, lips and throat black dotted.

Total length	119 mm.
Head	11 ,,
Width of head	8 ,,
Body	43 ,,
Fore-limb	16 ,,
Hind-limb	22 ,,
Tail	65 ,,

Habits.—Met with under logs and stones in moist and thickly timbered country and dense gullies.

Mode of reproduction.—Young developed within the body of the parent; three brought forth in January or February.

Distribution.—Victoria: Upper Yarra, Mount Baw Baw, South Gippsland.

Range outside Victoria.—Tasmania, Kent Group.

LIOLEPISMA TETRADACTYLUM, O'Shaughn.

Mocoa tetradactyla, O'Shaughn., Ann. and Mag. N.H. (5), iv., 1879, p. 300.

Description.—"The distance between the end of the snout and the fore-limb is contained once and one-third in the distance

between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, broadly in contact with the rostral, præfrontals, inner angles touching; frontal much shorter and narrower than the frontoparietal, in contact with the first and second supraoculars; four supraoculars; seven supraciliaries; frontoparietal single, followed by a minute interparietal; parietals forming a median suture; a pair of nuchals and a pair of temporals border the parietals; four labials anterior to the subocular. Ear-opening oval, smaller than the transparent palpebral disk, with a short obtuse lobule anteriorly. Thirty-four scales round the middle of the body, all perfectly smooth; dorsals largest, laterals smallest. Præanal scales not enlarged. The hind-limb reaches the wrist. Fingers four, toes five; subdigital lamellæ smooth, twenty under the fourth toe. Tail a little longer than head and body." *Colour.*—Olive-brown above, head with a few black specks; five interrupted black lines along the middle of the back, the median extending all along the tail, each alternate scale along the line being streaked with the pale ground colour, the black lines on the back often merged into a single broad band, within the area of which, alternate scales are streaked with the pale ground colour; a dorso-lateral series of black dots, separated from the median dorsal lines by a band of pale ground colour; sides immaculate, with two bright rosy-carmine (dull yellow in spirit specimens) stripes, the lower of which extends from axilla to groin, lower surfaces greenish.

Total length	... ...	117 mm.
Head	... ...	14 „
Width of head	... ...	10 „
Body	... ...	41 „
Fore-limb	... ...	16 „
Hind-limb	... ...	22 „
Tail	... ...	62 „

Habits.—This elegant little lizard is found amongst the grass and herbage on the dry, open plains near the Murray. Food consists of insects, chiefly locusts and grasshoppers.

Distribution.—Victoria: Brown's Plains, Barnawartha.

Range outside Victoria.—New South Wales, Queensland.

LYGOSOMA.

Sub-genus EMOA, Gray.

Limbs well developed, pentadactyle, overlapping when adpressed. Lower eyelid with an undivided transparent disk. Supranasals present.

EMOA SPENCERI, sp. nov.

(Plate 2, fig. 1, 1a.)

Description.—Head and body slightly depressed. Limbs well developed, pentadactyle. The distance between the end of the snout and the fore limb is contained once and one-third in the distance between axilla and groin. Snout obtusely pointed. Ear-opening about midway between the end of the snout and the fore-limb; eye about midway between the ear-opening and the tip of the snout. Lower eyelid with a very large transparent disk, nearly as large as the eye. Nostril pierced in a small nasal. Supranasals narrow, widely separated by the frontonasal; a narrow postnasal often fused with the supranasal; frontonasal much broader than long, forming a suture with the rostral and with the frontal; præfrontals well developed; frontal slightly longer than the frontoparietals, in contact with the first and second supraoculars; four supraoculars, second much the largest; seven supraciliaries; frontoparietals and interparietal distinct; parietals forming a suture behind the interparietal; a pair of nuchals and a pair of temporals border the parietals; seventh upper labial largest and entering the orbit. Ear-opening oval, oblique, smaller than the transparent palpebral disk, with three or four small lobules anteriorly. Forty-two to forty-four smooth scales round the middle of the body, dorsals largest, especially the two vertebral series, laterals smallest. A marginal row of slightly enlarged præanals. The adpressed limbs slightly overlap. Digits moderate, slightly compressed; subdigital lamellæ smooth, about twenty-two under the fourth toe. Tail slightly longer than head and body. *Colour.*—Dark-brown above with pale greenish-white markings of which the most constant is a dorsolateral band commencing above the eye and lost on the tail; usually with regular longitudinal series of light spots; sides blackish-brown light dotted, a narrow longitudinal line of the

above pale colour extending from the ear above the fore-limb to the groin. Lower surfaces bluish-green.

Total length	... ...	104 mm.
Head ...	... ...	10 „
Width of head	... ...	7 „
Body ...	... ...	39 „
Fore-limb	... ...	13 „
Hind-limb	... ...	18 „
Tail ...	... ...	55 „

Distribution—Victoria: Brandy Creek, Dandenong Ranges (Melb. Mus.); Dimboola, Gisborne, Croajingolong (L. and F.).

We have named this elegant little lizard after Prof. W. B. Spencer, M.A., Professor of Biology at the Melbourne University, to whom we are indebted for assistance in many ways during the preparation of this work.

Lygosoma.

Sub-genus Hemiergis, Wagl.

Limbs very short, with less than five digits. Lower eyelid with an undivided transparent disk. Ear covered with scales. No supranasals, præfrontals well developed. Frontal not broader than the supraocular region.

Hemiergis peronii, Fitz.

Tetradactylus decresiensis, Gray, Cat., p. 86.

Seps peronii, Fitzing, N. Class, Rept., p. 53; Gray, Griff. A.K., ix., Syn., p. 72.

Tetradactylus decresiensis, Cuv., R.A., 2nd ed., ii., p. 64; Dum. and Bibr., v., p. 764; Gray, Zool. Ereb. and Terr. Rept., pl. vi., fig. 4 (and details of head, fig. 1).

Hemiergis decresiensis, part., Steind, Novara, Rept., p. 50.

Description.—"Body much elongate; limbs very weak, tetradactyle; the distance between the end of the snout and the fore-limb is contained twice to twice and two-thirds in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal;

no supranasal; frontonasal broader than long, forming a narrow suture with the rostral and with the frontal; latter shield scarcely longer than the interparietal; in contact with the first and second supraoculars; four supraoculars, second largest; seven or eight supraciliaries; frontoparietals distinct, nearly as long as the interparietal; parietals forming a suture behind the interparietal; two or three pairs of nuchals; fifth upper labial below the centre of the eye, from which it is separated by a series of suboculars. Ear covered with scales, indicated by a depression. Eighteen or twenty smooth scales round the middle of the body; dorsals largest. A pair of enlarged præanals. The length of the hind-limb equals the distance between the centre of the eye and the fore-limb; third toe longest. Tail thick, once and a half to once and two-thirds the length of head and body. *Colour.*—Pale-brown or golden above, with or without minute brown dots; a black dorso-lateral line; sides grey, speckled with black; lower surfaces whitish, black spotted.

Total length	152 mm.	
Head	9 „	
Width of head	6·5 „	
Body	48 „	
Fore-limb	7 „	
Hind-limb	13 „	
Tail	95 „	"—Boulenger.

Habits.—Found under logs and flat stones on the hillsides and in gullies. Movements very slow.

Distribution.—Victoria: Dandenong Ranges (Melb. Mus.).

Range outside Victoria.—Kangaroo Island, Albany.

HEMIERGIS DECRESIENSIS, Gray.

Hemiergis decresiensis, Gray, Cat., pp. 87 and 272.

Zygnis decresiensis, Fitzing, N. Class, Rept., p. 53.

Tridactylus decresiensis, Cuv. R.A., 2nd. ed., 64; Gray, Griff. A.K., ix., Syn., p. 72.

Hemiergis decresiensis, Dum. and Bibr., v., p. 766; Gray, Zool. Ereb. and Terr. Rept., pl. vi., fig. 5.

——— *decresiensis*, part., Steind, Novara, Rept., p. 50.

Hemiergis polylepis, Günth., Ann. and Mag. N.H. (3), xx., 1867, p. 48.

Description.—"Body much elongate; limbs very weak, tridactyle; the distance between the end of the snout and the fore-limb is contained twice and one-fourth to twice and a half in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, forming a narrow suture with the rostral and with the frontal; latter shield not longer than the interparietal; in contact with the first and second supraoculars; four supraoculars, second largest; seven or eight supraciliaries; frontoparietals distinct, nearly as long as the interparietal; parietals forming a suture behind the interparietal; no enlarged nuchals; fifth upper labial below the centre of the eye, from which it is separated by a series of suboculars. Ear covered with scales, indicated by a depression. Twenty-four smooth scales round the middle of the body, subequal. A pair of enlarged præanals. The length of the hind-limb equals the distance between the centre of the eye and the fore-limb; second toe slightly longer than the third. *Colour.*—Pale-brown above, four longitudinal series of black dots, sometimes confluent into lines, on the back; a black dorso-lateral line; sides grey, black dotted; lower surfaces yellowish, throat and tail black spotted."—Boulenger.

Total length	... ...	102 mm.
Head ...	... ...	8 ,,
Width of head	... ...	5 ,,
Body ...	... ...	39 ,,
Fore-limb	... ...	6·5 ,,
Hind-limb	... ...	10 ,,
Tail ...	... ...	55 ,,

Habits.—Similar to former species.

Distribution.—Victoria: Ferntree Gully, Beechworth.

Range outside Victoria.—South Australia, Kangaroo Island.

Lygosoma.

Sub-genus Siaphos, Gray.

Limbs more or less developed. Lower eyelid scaly, or with a transparent disk. Ear covered with scales or very minute.

No supranasals. Præfrontals (in species with short limbs) minute or absent. Frontal not broader than the supraocular region.

SIAPHOS MACCOYI, sp. nov.

(Plate 2, fig. 2, 2a.)

Description.—Body much elongate, limbs weak, pentadactyle; the distance between the end of the snout and the fore-limb is contained about three times in the distance between axilla and groin. Snout short, obtusely pointed. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal very broad, forming a broad straight suture with the rostral, and a curved one with the frontal; præfrontals absent; frontal not longer than the frontoparietals, in contact with the first and second supraoculars; five supraoculars, second largest; seven supraciliaries; frontoparietals and interparietal distinct; parietals forming a suture behind the interparietal; a pair of nuchals and a pair of temporals border the parietals; fourth upper labial below the centre of the eye. Ear opening distinct, minute. Twenty smooth scales round the middle of the body. Præanals not enlarged. The length of the hind-limb scarcely equals the distance between the centre of the eye and the fore-limb. Fourth toe not longer than the third, with six or seven smooth lamellæ inferiorly. *Colour.*—Brown or greyish-brown above, each dorsal scale with three or four minute dark longitudinal lines; a more or less distinct black dorsolateral line extending from the eye to the base of the tail; ground colour of lateral scales brownish, or greyish, sometimes nearly white, each with irregular minute darker streaks; throat ivory-white spotted with brown; belly bright-yellow immaculate; under surface of tail bright-yellow, more or less covered with blackish-brown blotches.

Total length	139 mm.
Head	8 ,,
Width of head	4·5 ,,
Body	48 ,,
Fore-limb	6 ,,
Hind-limb	9 ,,
Tail	83 ,,

Habits.—Usually met with under logs and flat stones in moist places. Movements very slow.

Mode of reproduction.—Young developed within the body of the parent, eight or nine being brought forth in January or February.

Distribution.—Victoria: Brandy Creek, Trafalgar, Waterloo, Lakes Entrance, Ferntree Gully, Fernshaw, Dandenong Ranges, Goulburn Valley (Melb. Mus.); Ringwood, Dandenong Ranges, Berwick, Plenty Ranges, Upper Yarra, Croajingolong, North and South Gippsland (L. and F.).

We have named this graceful little lizard after Sir Frederick McCoy, K.C.M.G., &c., through whose kindness and courtesy we have been able to examine a large number of specimens preserved in the National Museum of Victoria.

LYGOSOMA.

Sub-genus RHODONA, Gray.

Limbs short or rudimentary. Lower eyelid with a transparent disk. Ear distinct, minute. No supranasals. Præfrontals very small and widely separated, or absent. Frontal not broader than the supraocular region.

RHODONA BOUGAINVILLII, Gray.

Lygosoma bougainvillii, Gray, Cat., p. 85.

Riopa bougainvillii, Gray, Ann. and Mag. N.H., ii., 1839, p. 332.

Lygosoma bougainvillii, Dum. and Bibr., v., p. 716; Günth., Zool. Ereb. and Terr. Rept., p. 13.

——— *laterale*, (non Say), Günth., Ann. and Mag. N.H. (3), xx., 1867, p. 46.

Description.—"Body much elongate, limbs weak; the distance between the end of the snout and the fore-limb is contained twice to twice and a half in the distance between axilla and groin. Snout moderate, obtusely conical. Lower eyelid with an undivided transparent disk. Nostril pierced in a rather large nasal, which is in contact with its fellow, frontonasal large, broadly in contact with the rostral; præfrontals small, and

widely separated; frontal broader than the supraocular region, longer than the frontoparietals and interparietal together; in contact with the first and second supraoculars; four supraoculars, second largest; fourth very small; six supraciliaries; frontoparietals and interparietal distinct, sub-equal; parietals forming a suture behind the interparietal; two or four pairs of nuchals; fifth upper labial entering the orbit. Ear-opening minute, not or scarcely larger than the nostril. Twenty-two or twenty-four smooth scales round the middle of the body; dorsals largest. A pair of large præanals. The length of the hind-limb equals the distance between the nostril and the fore-limb; toes slender, slightly compressed, fourth much longer than third; subdigital lamellæ feebly keeled, fifteen to eighteen under the fourth toe. Tail slightly longer than head and body. *Colour.*—Greyish above, with blackish dots or short lines along the series of scales; a black lateral band, passing through the eye; flanks white, black dotted; lower surfaces white.

Total length	135	mm.	
Head	9	„	
Width of head	6	„	
Body	54	„	
Fore-limb	8	„	
Hind-limb	14	„	
Tail	72	„	"—Boulenger.

Habits.—Met with under logs and stones in moist places, where they frequently make excavations in the ground. Movements slow.

Distribution.—Victoria: Melbourne, Keilor, Pyramid Hill, Western District (Melb. Mus.); Carrum, Bacchus Marsh, Castlemaine, Grampians, Beechworth, Mt. Stanley (L. and F.).

Range outside Victoria.—South Australia, Kangaroo Island.

RHODONA PUNCTATOVITTATA, Günth.

Rhodona punctatovittata, Günth., Ann. and Mag. N.H. (3), xx., 1867, p. 47.

——— *officeri*, McCoy, Prodr. Zool. Vict., dec. vi., pl. li.

Description.—" Body much elongate; limbs very weak, anterior monodactyle, posterior didactyle; the distance between the end

of the snout and the fore-limb is contained more than three times in the distance between axilla and groin. Snout subcuneiform, with slightly projecting labial edge. Eye very small. Lower eyelid with an undivided transparent disk. Nostril pierced in a large swollen nasal, which forms a suture with its fellow; fronto-nasal much broader than long, forming a broad suture with the frontal; præfrontals small and widely separated; frontal much broader than the supraocular region, in contact with the first and second supraoculars and with the interparietal; supraoculars three, small, second largest; six supraciliaries; frontoparietals small, much smaller than the interparietal; parietals forming a suture behind the interparietal; four pairs of nuchals; fourth upper labial entering the orbit. Ear-opening scarcely distinguishable. Eighteen smooth scales round the middle of the body, dorsals largest, ventrals smallest. A pair of enlarged præanals. Fore-limb nearly as long as the snout; hind-limb as long as the distance between the ear and the fore-limb; second toe more than twice as long as first." *Colour.*—Rich brown above, each scale with a black spot, the spots forming six or eight longitudinal rows; head-shields black-edged; lower surfaces pale yellow-ochre.

Total length	...	...	169 mm.
Head ...	...	...	10 „
Width of head	...	...	6·5 „
Body ...	...	...	75 „
Fore-limb...	...	...	3·5 „
Hind-limb	...	...	10 „
Tail ...	...	...	84 „

Habits.—Found in loose sandy soil, into which it burrows.

Distribution.—Victoria: Swan Hill.

Range outside Victoria.—Queensland.

ABLEPHARUS, Fitzing.

Palatine and pterygoid bones in contact mesially, the palatal notch not extending forwards to between the centre of the eye; pterygoids toothless. Maxillary teeth conical. No movable eyelids, a transparent disk covering the eye. Ear distinct or

hidden. Nostril pierced in the nasal; supranasal present or absent. Limbs more or less developed.

The genus extends over south-eastern Europe, south-western Asia, Tropical and South Africa, and Australia.

ABLEPHARUS BOUTONII, Desj.

Cryptoblepharus boutonii, Gray, Cat., p. 64.

Scincus boutonii, Desjard, Ann. Sc. Nat., xxii., 1831, p. 298.

Ablepharus leschenaulti, Cocteau, Mag. de Zool., 1832, Rept., pl. i.

Ablepharus pœcilopleurus, Weigm., N. Acta Ac. Leop.-Carol, xvii., 1835, i., p. 202, pl. viii., fig. 1; Günth, Proc. Zool. Soc., 1874, p. 296.

Cryptoblepharus peronii, Cocteau, Et. Scinc., p. 1.

——— *leschenaultii*, Coct., l.c.

Cryptoblepharus pœciiopleurus, Gray, Ann. N. H., ii., 1839, p. 335, and Zool. Ereb. and Terr. Rept., pl. v., fig. 2.

Tiliqua buchanani, Gray, Ann. N. H., ii., p. 291.

Ablepharus peronii, Dum. and Bibr., v., p. 813; Peters, Mon. Berl. Ac., 1854, p. 619; Bavay, Cat., Rept., N. Caléd., p. 31.

Cryptoblepharus eximius, Girard, Proc. Ac. Philad., 1857, p. 195, and U. S. Explor. Exped., Herp., p. 222, pl. xxvi., figs. 25-32.

——— *plagiocephalus*, Girard, U. S. Explor. Exped., Herp., p. 220, pl. xxvi., figs. 17-24.

(?) Ablepharus nigropunctatus, Hallow., Proc. Ac. Philad., 1860, p. 487.

Ablepharus boutonii, Strauch, Mél. Biol. Acad., St. Pétersb., vi., 1869, p. 566, and Bull, xii., p. 368; Günth, l.c.; Peters and Doria, Ann. Mus., Genova, xiii., 1878, p. 339; Peters, Reise, n. Mossamb., iii., p. 77.

——— *quinquetæniatus*, Günth, l.c.

Ablepharus rutilus, Peters, Sitzb., Ges. Nat. Freunde, 1879, p. 37.

——— *(Cryptoblepharus) boutonii*, Bocourt, Miss. Sc. Mex., Rept., p. 463, pl. xxii., H., fig. 1.

—— (———) *leschenaultii*, Bocourt, l.c.

—— (———) *peronii*, Bocourt, l.c.

Ablepharus boutonii, var. cognatus, Boettg., Zool., Anz., 1881, p. 359; and Abh. Senck., Ges., xii., 1881, p. 454, pl. ii., fig. 4.

Description.—"Snout pointed, rostral not projecting. Eye entirely surrounded by a circle of granules; upper eyelid represented by three or four larger scales. Rostral largely in contact with the frontonasal; præfrontals either forming a suture or narrowly separated; frontal small, in contact with the first and second supraoculars, in contact with or separated from the interparietal; latter very large, formed by fusion with the fronto-parietals; five supraoculars, second largest, fifth smallest; five or six supraciliaries, second largest; a pair of large nuchals. Ear-opening roundish, about as large as the pupil. Scales smooth, or feebly striated; twenty to twenty-eight round the middle of the body; dorsals largest; the two median series strongly dilated transversely in specimens with fewer (twenty or twenty-two) longitudinal series of scales. Limbs well developed, pentadactyle; the hind-limb reaches the axilla, or not so far; digits long and slender, smooth inferiorly. Tail a little longer than head and body." *Colour.*—Greenish, or bluish above, strongly metallic, covered with small blackish spots, sides sometimes with irregular lighter and some darker bands; lower surfaces greenish or bluish-white.

Total length	...	...	105	mm.
Head ...	...	...	10	„
Width of head	...	...	6	„
Body ...	...	...	33	„
Fore-limb	...	...	15	„
Hind-limb	...	...	19	„
Tail ...	...	...	62	„

Habits.—Usually met with on fences, fallen trees, and tree-stumps, into the crevices of which it quickly disappears on the approach of an enemy. It soon reappears, when, by the exercise of a little patience, it may be easily captured.

Distribution.—Victoria: Grampians, Western District (Melb. Mus.); Dimboola, Swan Hill, Baringhup, Brown's Plains (L. and F.).

Range outside Victoria.—Irregularly distributed over the hotter parts of both hemispheres.

ABLEPHARUS LINEO-OCELLATUS, Dum. and Bibr.

Cryptoblepharus lineo-ocellatus, Gray, Cat., p. 65.

Morethia anomalus, Gray, l.c.

Ablepharus lineo-ocellatus, Dum. and Bibr., v., p. 817; Strauch, Mél. Biol. Ac., St. Pétersb., vi., 1868, p. 569, and Bull, xii., p. 371.

Cryptoblepharus lineo-ocellatus, Gray, in Grey's Trav. Austr., ii., p. 427.

Morethia anomalus, Gray, Zool. Ereb. and Terr. Rept., p. 4, pl. v., fig. 1.

Ablepharus anomalus, Strauch, l.c., pp. 570, 571.

Morethia anomala, Günth, Zool. Ereb. and Terr. Rept., p. 10.

Ablepharus (Morethia) anomalus (adelaidensis), Peters, Mon. Berl. Ac., 1874, p. 376.

Description.—"Snout short, obtuse, rostral not projecting. Eye entirely surrounded by a circle of granules. Rostral largely in contact with the frontonasal, which is in contact with the frontal; latter shield nearly as long as, but narrower than the interparietal, which is formed by fusion with the frontoparietals; four supraoculars, second and third largest, first and second in contact with the frontal; six supraciliaries, third to fifth usually very large, sixth minute; a pair of nuchals; four (or five) labials anterior to the subocular; supranasals sometimes present. Ear-opening rather large, oval, with one or several projecting small lobules anteriorly. Scales subequal in size, twenty-four to thirty round the middle of the body. Limbs well developed, pentadactyle; the hind-limb does not reach the axilla; digits obtusely keeled inferiorly. Tail longer than head and body. *Colour.*—Olive or brownish above, black spotted, or with light black-edged ocelli; a more or less strongly marked blackish lateral band, edged below by a white black-edged streak which extends from the eye or ear to the groin; a white black-edged spot or streak between the thigh and the tail; lower surfaces yellowish, or greenish-white.

Total length	...	...	108	mm.	
Head	...	...	9	,,	
Width of head	...	...	6	,,	
Body	...	...	31	,,	
Fore-limb...	...	...	11	,,	
Hind-limb	...	...	17	,,	
Tail	...	...	68	,,	"—Boulenger.

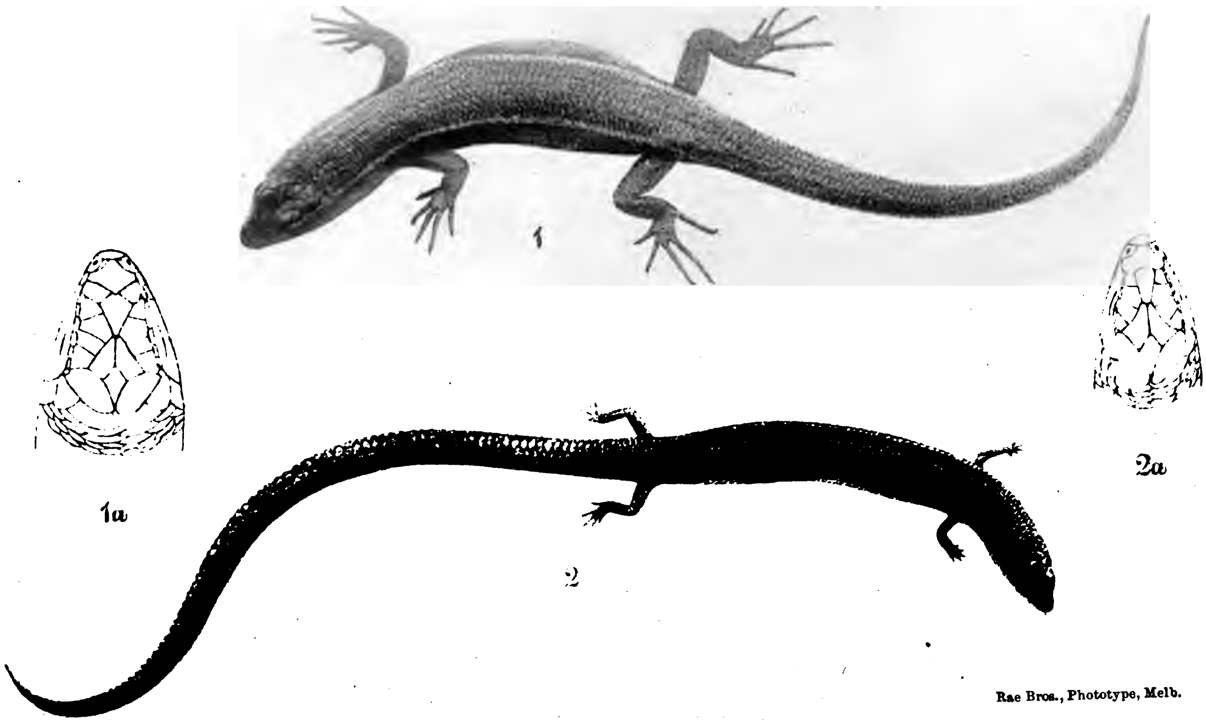
Habits.—Habits similar to those of *A. boutonii.*

Distribution. — Victoria : Melbourne, Goulburn Valley, Western District (Melb. Mus.); Dimboola (L. and F.).

Range outside Victoria.—South Australia, Kangaroo Island, West Australia.

DESCRIPTION OF PLATE II.

Fig.	1.—Emoa spenceri, L. and F.			
,,	1a.	,,	,,	upper view of head.
,,	2.—Siaphos maccoyi, L. and F.			
,,	2a.	,,	,,	upper view of head.



Rae Bros., Phototype, Melb.

FIG. 1, EMOA SPENCERI. FIG. 2, SIAPHOS MACCOYI.

Art. III.—*Further Notes on Australian Hydroids, with Descriptions of some New Species.*

(With Plates III., IV., V., VI.)

By W. M. Bale, F.R.M.S.

[Read April 13, 1893.]

The hydroids treated of in the present paper were mostly comprised in a collection made by Mr. J. Bracebridge Wilson, M.A., and forwarded to me a considerable time since for examination and report in connection with the work of the committee appointed by this Society to investigate the fauna of Port Phillip. Many of the species included in the collection had already been described and recorded from that locality, and of these for the most part no particular mention is here necessary; but in a few cases the specimens present more or less distinct varietal features, which I have duly noted, and in two or three other instances they include the gonangial capsules, which had not previously been observed. A few of the species had not been recorded from Port Phillip, and among them were nine which proved to be new to science. Two of these, however (one of them forming the type of a new family), have since been described and figured with careful and elaborate detail by Professor Spencer in the Transactions of this Society, under the names of *Plumularia procumbens* and *Clathrozoon wilsoni.*

One Calyptoblastic species probably represents an undescribed genus, but as the specimens consist merely of the polypidom, I content myself with giving a description and figure (without names), pending the discovery of specimens in a fit condition to admit of its true affinities being ascertained. The genus *Halocordyle*, not hitherto known to occur in Australia, is represented by a single incomplete specimen.

Some good examples of *Diplocheilus mirabilis*, Allman, have on examination satisfied me that the character on which the genus was founded, namely, the presence of a secondary envelope

to the hydrotheca, is, as I have previously suggested, illusory, the appearance of an outer calycle being caused by a solid thickening of the perisarc, such as is common in the hydrothecæ of many *Plumulariæ* and at intervals along the hydrocladia of nearly all; while the discovery that this species possesses mesial nemataphores which are unprovided with sarcothecæ assigns to it a place under Jickeli's genus *Kirchenpaueria*, to which genus also it is now evident that the very closely related species *Azygoplon productum (Plumularia producta)*, Bale, must also be relegated.

Two or three species of *Eudendrium* are included in the collection, but although the hydranths are present, their condition is not such as to enable me to decide satisfactorily whether they are to be referred to any of the species already known, some of which differ very slightly from each other, especially in regard to the polypidom. In such cases it appears very desirable that confusion of species should be avoided by describing only such forms as are examined in a perfectly fresh condition, and in which the gonosome is present, as the smallest details, even the colour, must be taken into consideration.

My thanks are due to Mr. A. J. Campbell, F.L.S., for specimens of three or four species representative of the unexplored hydroid-fauna of Western Australia, one of them—a large species of *Aglaophenia*—being new; also to Dr. MacGillivray for a new species of *Plumularia* from the Snowy River, as well as a few other specimens.

HALOCORDYLE AUSTRALIS, n. sp.

Hydrocaulus branched (monosiphonic ?), small branches biserial, alternate, polypiferous ramuli biserial, rather irregular, both series directed to the front; all branches strongly and closely ringed for a considerable distance above their point of origin and above the point at which other branches spring from them; polypiferous ramuli and some of the others ringed throughout; polypiferous ramuli not expanded towards the aperture. Hydranths large, flask-shaped, with a stout cylindrical proboscis rounded at the top, about 8 or 10 filiform tentacles springing from the lower part of the body, and four or five short capitate tentacles surrounding the proboscis.

Gonophores pedunculate, borne on the lower part of the hydranth within the circle of filiform tentacles, umbrella with a small opening and four radial canals, manubrium large.

Larger branches deep red-brown, smaller ones lighter.

Hab.—Port Phillip Bay (Mr. J. B. Wilson).

I have only seen a single mounted specimen of this species, and cannot therefore give full particulars of its size and habit. So far as it goes the specimen is monosiphonic, with the small branches alternately directed slightly to the right and the left, while the polypiferous ramules are also directed slightly to right and left, but are not strictly alternate, two often following on the same side. The polypidom could be readily distinguished from that of any other Australian hydroid known to me by the extent and distinctness of the annular wrinkling of the perisarc, which answers to Ellis' description of a "tubulous coralline wrinkled like the windpipe" far more closely than does the *Tubularia larynx* to which that description was applied.

The hydranths differ from those of *Pennaria australis* in no important particular except in having the capitate tentacles fewer in number and confined to a single circlet round the base of the proboscis, instead of being scattered irregularly over the body. It is possible that the number of the filiform tentacles is habitually double that of the capitate ones, but I had not a sufficient number of hydranths in which the tentacles could be counted to satisfy myself that such was the case.

The gonophores, which are borne one or two on a hydranth, are small and regularly ovate, and like those of *Ceratella* as figured by Professor Spencer, are quadrate in transverse view, owing to the enlargement of the umbrella at the four sides where the radial canals are situated. In side view the umbrella is seen to thin rapidly away to the small orifice at the summit (which is closed in by the ectotheca), and no traces of tentacles could be detected. In these points they agree with the immature gonophores of *Pennaria* (except that the structure of the umbrella is more distinct), and it is probable that they also agree with them when mature in being completely open and in the possession of rudimentary tentacles, which condition exists also in the species of *Halocordyle* already known (*H. tiarella*).

CLATHROZOON WILSONI, Spencer.

(Trans. Royal Soc. Vict., Vol. II, Part I.)

This hydroid was represented only by the polypidom in the collection which I received from Mr. Wilson; other specimens, which the same gentleman collected later on, and which included the soft parts, were forwarded to Professor Spencer, who has described them as the type of a new family.

——— ——, n. gen., and sp.?

(Plate III., figs. 1, 2.)

Hydrocaulus nine inches (or more) in height, consisting of a stout monosiphonic stem with a few ascending branches, nearly equal in diameter for the greater part of its length, not distinctly jointed, very irregular in shape, being much swollen about the origin of the polyp-tubes; polyp-tubes given off on all sides without any regular order, sometimes very short, scarcely projecting, but usually about as long as the diameter of the stem, straight, or more often irregularly bent or twisted, terminating in a stout annular thickening, darker in colour than the rest. Hydranths unknown.

Gonophores solitary, borne on peduncles which occupy tubes like those of the hydranths.

Hab.—Port Phillip Bay (Mr. J. B. Wilson).

The hollow stem averages about $\frac{1}{30}$ to $\frac{1}{25}$ of an inch in diameter, but varies greatly at different points, owing mainly to its inflated condition at those parts where the polyp-tubes originate. The latter also are far from uniform in shape and size, often having a distorted appearance, and being sometimes, but not invariably, a little expanded at the summit. Here and there the margin, with its thickened ring, is duplicated, as in many caliculate species. There are no hydrothecæ, and I failed to find any hydranths; but one or two of the lower tubes bore gonophores, which appeared to take the form of ovate or oblong sacs, without openings at the summit, but were not in sufficiently good condition to admit of their structure being accurately determined.

I refrain from naming this species at present, as in the absence of the hydranths it is impossible to decide whether it forms the type of a new genus, or whether it may be possible to refer it to one already established.

CAMPANULARIA.

The only species of this genus which I have to describe, though small and of simple habit, agrees in all its more important characteristics with the two or three species for which Professor Allman has proposed the genus *Thyroscyphus*. It is true that a four-sided operculum is given as a feature of that genus, while in *C. tridentata* the operculum is three-sided; but the precise number of opercular valves is obviously not of generic importance; in another direction, however, the genus is unsatisfactory, namely in separating species which are exceedingly close allies, differing in no important particular except in the presence or absence of the operculum. For example, the *Campanularia insignis* of the *Challenger* Report and the *Campanularia Torresii* of Busk (*Thyroscyphus simplex*, Allman) and *T. ramosus*, Allman, are all so closely related that no arrangement which separates them can be regarded as satisfactory. The species mentioned, with some others, though having shortly pedunculate hydrothecæ, are, in regard to the arrangement of the latter and the ramification, more like the genus *Sertularella* than the typical members of the Campanularian family; and as in *Sertularella*, the hydrothecæ may have three or four emarginations of the border, with an operculum of the same number of valves, or may be entire and destitute of any operculum. It cannot be maintained that the presence or absence of the operculum in the one group is in the slightest degree more important than in the other, and as Professor Allman is doubtless justified in remarking concerning species of *Sertularia* provided with membranous opercular valves that "few systematists would think of separating these generically from the closely allied species in which no valves are present," it seems to follow that such separation is equally unwarranted in the Campanularian group. Undoubtedly such species as *C. insignis* and *C. Torresii* form a group distinct from the typical *Campanulariæ*, and it would perhaps be advisable to unite them in a single genus, which, ranking under the CAMPANULARIIDÆ,

would yet exhibit strong affinities with the Sertularians. This was recognised by Lamarck, who included such species as a section of the genus *Sertularia*, thereby, however, placing them on the wrong side of the boundary line.

Campanularia tridentata, n. sp.

(Plate III., fig. 3.)

Hydrocaulus simple, about half an inch in height, each internode bearing a short process from which springs a hydrotheca. Hydrothecæ alternate, tubular above, curving inwards towards the base on the upper side only, so that the lower or outer wall of the cell is straight or concave, while the upper is strongly convex; aperture with three pointed teeth (or three deep emarginations), and an operculum of three pieces.

Gonothecæ?

Hab.—Port Phillip Bay (Mr. J. B. Wilson).

This is a member of the group which includes operculate species such as *C. Torresii* and inoperculate species like *C. insignis* and *C. rufa*. From such of the former as are already known it differs in having three valves instead of four, as well as in its small size and simple habit. In this group each hydrotheca usually springs, as in *Sertularella*, from a distinct internode; the hydrothecæ have short peduncles of one or two joints only, and they are mostly gibbous above the base on the side next the hydrocaulus, but less so or not at all on the outer side. In *C. tridentata* the margin of the hydrotheca proper is scarcely thicker than the valves into which it is continued; the line of demarcation is therefore not conspicuous.

Campanularia insignis, Allman.

This species, described in the *Challenger* Report, appears to be the same which Busk identifies with the *Laomedea antipathes* of Lamouroux. Busk says of *Laomedea Torresii* that "at first sight it is very like *L. antipathes*, Lamx., which occurs in New Zealand, but differs materially in its smaller size and in the four shallow emarginations of the mouth, which part in *L. antipathes* is entire and with the margin a little thickened." As *Campanu-*

laria (Laomedea) Torresii differs from *C. insignis* in precisely these particulars, there is every probability that Busk was speaking of the latter species under the name of *L. antipathes;* it is very doubtful, however, whether it was really the same as that described by Lamouroux; indeed, if the figure given by the latter be at all correct, it cannot be intended for the species mentioned by Busk.

THYROSCYPHUS SIMPLEX, Allman.

The species described under the above name in the *Challenger* Report is identical with *Campanularia Torresii*, Busk, (*Laomedea Torresii* of the "Voyage of the *Rattlesnake*"). Both Busk's and Allman's types came from Torres Strait, and appear to have been wholly alike, except that the latter was a rather larger specimen.

OBELIA GENICULATA, Lin.

A dwarf variety, about one-fourth of an inch in height, and with all its parts small in proportion. The thickenings of the stem-internodes, which give the species its characteristic appearance, are, especially towards the bases of the shoots, even more strongly developed than in the larger forms.

The *Monosklera pusilla* of von Lendenfeld appears to be identical with this variety, so far as can be judged from a comparison with some of the type specimens, from which, however, the hydrothecæ have fallen off.

Port Phillip Bay (Mr. J. B. Wilson).

HALECIUM GRACILE, Bale.

Port Phillip Bay (Mr. J. B. Wilson).

The female gonothecæ when mature have the summit notched like those of *H. parvulum*,* and do not differ greatly from them in other respects; it would appear, therefore, that the differences which I have shown as existing between them may depend largely on their state of development. The male gonothecæ are considerably longer than those of my former specimens, which were evidently immature.

* Proceedings of the Linnean Society of New South Wales, 1888, p. 759.

It is not impossible that *H. gracile* and *H. parvulum* may ultimately prove identical, but so far all my specimens of the former have been monosiphonic, while the opposite condition characterises those of *H. parvulum*.

Sertularia unguiculata, Busk.

A form of this protean species differing from those which I have hitherto examined in the total absence of the short internodes, which in most varieties occupy the distal portion of the pinnæ, and which bear only one pair of hydrothecæ each. In the present form all the hydrothecæ are as a rule closely adnate, and the pinnæ have rarely more than one distinct joint in their whole length, and in the majority of cases not even one.

Port Phillip Bay (Mr. J. B. Wilson).

Sertularia tuba, Bale.

These specimens differ from others which I have examined in the possession of a slender stem some four inches or perhaps more in height, which gives off throughout its whole extent numerous pinnate branches about ¾-inch in length. The stem, though slender in proportion to its length, is thicker and darker than the branches, but bears hydrothecæ similarly arranged; it tends towards a fascicled condition, being strengthened by one or two supplemental tubes, which also give off hydrothecal ramuli. I at first concluded that this was a distinct variety, but it is quite possible that it may only be a more fully developed stage of the usual form, with which, in minute structure, it entirely agrees.

Port Phillip Bay (Mr. J. B. Wilson).

Sertularella.

In the *Challenger* Report Professor Allman suppresses the genus *Sertularella* on the ground that the distinctions relied upon to justify its separation from *Sertularia* break down on a critical comparison of a large number of species of the two groups. He does not allude, however, to what I have always regarded as the principal characteristic of the genus *Sertularella*, namely, the fact that each hydrotheca, at least on the smaller branches,

occupies a distinct internode, while in *Sertularia* there are one or more *pairs* on an internode, and in *Thuiaria* two series which are not paired. A great many species of *Sertularella* have been described by different authors, and the essential character mentioned above seems to be common to all of them, except in the case of two which were described by Professor Allman in his paper on Australian, Cape, and other Hydroida, in the Journal of the Linnean Society for 1885. One of these—*S. diffusa*—seems to be a true *Sertularia*, with two pairs of alternate hydrothecæ on each internode; the other—*S. trochocarpa*—undoubtedly exhibits strong affinities with *S. Johnstoni* and similar species, especially in the form of the gonangia, while at the same time the arrangement of the sub-alternate hydrothecæ (a pair on each internode) would require it to be placed in the genus *Sertularia*, an affinity indicated also by the form of the hydrotheca-margin. It may therefore be regarded as a transitional form of that genus.

SERTULARELLA LONGITHECA, Bale.

(Plate IV., figs. 7–9.)

Gonothecæ with three longitudinal angles, one dorsal and two lateral, the latter more acute and prolonged upwards into two large erect conical hollow processes, dorsal angle sometimes having a similar conical summit, but often terminating in a slight shoulder about the level of the aperture; summit of the gonangium forming a broad truncated cone between the processes, with a depression at the top from which rises a small conical neck, with narrow aperture.

Port Phillip Bay (Mr. J. B. Wilson).

The form of the gonotheca was previously somewhat doubtful, as I had only a single distorted specimen. When the dorsal angle is not prolonged upward the gonotheca in front view is not unlike those of *Sertularia elongata*, except in the elevated and narrow aperture. There are no transverse undulations, but the gonotheca is covered with delicate wavy transverse striæ, which appear to be minute ridges.

The largest specimen is about four inches long, with five or six distant ascending branches.

Sertularella macrotheca, Bale.

(Plate IV., fig. 3.)

The gonangia are smaller than those of my former specimens, and have the transverse undulations much deeper, closely approximating to those of *S. solidula*.

Port Phillip Bay (Mr. J. B. Wilson).

Sertularella Johnstoni, Gray.

Some of the specimens have the hydrothecæ more conical than the commoner forms, therein resembling specimens from New Zealand, but agreeing with other Victorian specimens in the shape of the gonothecæ.

Port Phillip Bay (Mr. J. B. Wilson).

Sertularella angulosa, n. sp.

(Plate IV., fig. 6.)

Shoots simple, short, zig-zag, divided by slightly-twisted joints into internodes, each bearing a hydrotheca on its upper part. Hydrothecæ adnate from one-third to one-half their height, large, divergent, barrel-shaped, but smaller towards the summit, with about six distinct sharp annular ridges; aperture expanding, with four teeth; three internal compressed vertical teeth, two of which are within the two upper emarginations of the border, and the third opposite the inferior marginal tooth.

Gonothecæ ?

Hab. ?

In habit resembling *S. polyzonias*, but the lower internodes are mostly more strongly zig-zag than in that species, while the hydrothecæ are less contracted above in proportion to the diameter of the lower portion, are not adnate for so far, and are more particularly differentiated by the distinct ridges encircling them. The internal vertical teeth are arranged exactly as in *S. polyzonias* and *S. microgona*, and, as in those species, are so delicate and transparent as to be easily overlooked, especially when the hydrothecæ are not perfectly free from the soft parts.

The specimens, of which there were very few, only reached about one-fifth of an inch in height, but were doubtless immature. The perisarc of the lower portions was rather thick.

Synthecium patulum, Busk.

Specimens about two inches in height, with several of the pinnæ anastomosing. Some of the hydrothecæ are much stouter and less curved than usual, with the margin more deeply sinuated at the sides, while the portions of the internode outside of the hydrothecæ are correspondingly diminished; the hydrothecæ thus occupy almost the whole internode. These modified internodes are mixed on the same pinna with the normal form.

Mouth of Snowy River (Dr. MacGillivray).

Thuiaria lata, Bale.

(Plate IV., fig. 1.)

Gonothecæ borne two or three on a pinna, springing from between the two series of hydrothecæ, very large (about $\frac{1}{8}$-inch long), gradually tapering downward, thickest part a little below the summit; presenting, as seen in side view, a dorsal and a ventral aspect, the former regularly undulated most of its length, the latter smooth; summit concave and oblique, more elevated at the back than in front.

Port Phillip Bay (Mr. J. B. Wilson).

(The gonothecæ of this species have not hitherto been described).

Thuiaria fenestrata, Bale.

(Plate IV., fig. 2.)

Port Phillip Bay (Dr. MacGillivray).

The gonothecæ are more nearly globular than those of any other species known to me. The sketch of one of them by Mr. Busk, which I copied in the "Catalogue of the Australian Hydroid Zoophytes," and from which I took the description, is evidently erroneous, which may possibly be due to some other species having been mixed with the material. The description in the "Voyage of the *Rattlesnake*" did not mention the gonosome.

Idia pristis, Lamx.

(Plate IV., figs. 4, 5.)

In the *Challenger* Report Professor Allman has given a more complete account of this remarkable hydroid than had previously been possible, having had the advantage of examining specimens sufficiently well preserved to exhibit much more of the detail than could be made out in ordinary dried specimens. It is through an oversight, however, that Professor Allman states in two different parts of his work that the species had previously been known only from Lamouroux' inadequate figure and description and a short notice of the gonosome by Mr. Hincks in the Journal of the Linnean Society of London for 1887, since I had in 1884 described and figured both trophosome and gonothecæ, while Mr. Busk had described the species in 1852, in the "Voyage of the *Rattlesnake*," from which notice I first identified it. The description of the gonothecæ, however, in the work just mentioned was an error, the object described being a parasitic hydroid (*Campanularia costata ?*); but Mr. Busk afterwards observed the true gonothecæ and made sketches of them, which I reproduce. The figures of the gonothecæ given in the *Challenger* Report differ considerably from the specimens I have seen (which resemble Mr. Busk's figures), especially in showing the longitudinal ribs much closer and terminating at the shoulder instead of continuing up to the margin, while they give no indication of the curved wrinklings of the surface which form series of irregular arches joining all the ribs. Possibly the latter feature is a result of the drying of the perisarc, and therefore not present in well-preserved specimens which have not been dried. The gonothecæ are apt to be very irregular in form, sometimes being deeply constricted round the middle, while others have the characteristic ribs absent in parts, and represented by a totally irregular wrinkling of the surface. According to Professor Allman, the hydrothecæ have the peculiarity of opening backwards by a small valvular operculum, but in specimens which have been dried it is scarcely possible to make out the exact form of the aperture, owing to the collapsibility of the delicate perisarc at that part. The stems of the *Challenger* specimens appear to be more slender than usual, and the axillary hydrothecæ are

figured like the others on the stem, while in my specimens they are smaller than the rest, and are curved over so as to point directly to the back of the polypidom.

AGLAOPHENIA PARVULA, Bale, var.

Larger than the type, reaching two to three inches in height, and branched, branches nearly in the same plane.

Port Phillip Bay (Mr. J. B. Wilson).

The largest specimen bore five or six branches, one of which was again branched. I have formerly described the hydrotheca of *A. parvula* as having five teeth on each side, two of which are often folded together so as to resemble a single tooth; judging from most of the specimens I have since observed, however, it would be more correct to describe the number of teeth as four on each side, one of them being sometimes folded and bifid, the latter being the exceptional rather than the normal condition.

AGLAOPHENIA (?) WHITELEGGEI, Bale.

Port Phillip.

Of this species, hitherto known only from New South Wales, I have received specimens both from Mr. Wilson and Dr. MacGillivray. The largest specimen is about four inches in height, with a slender stem formed of two tubes in addition to the original jointed filament, and the branches given off most freely towards the summit, so that the polypidom is somewhat cymose. In all the specimens I have observed the peri sarc is very delicate, so much so that nearly all the cells are generally more or less collapsed and distorted after mounting or drying.

AGLAOPHENIA CARINATA, n. sp.

(Plate VI., figs. 1-3.)

Hydrocaulus polysiphonic, reaching a height of about eighteen inches, much and irregularly branched, stem and main branches thick, branches ascending, pinnæ short, alternate, one on each internode, both series springing from the front. Hydrothecæ set at an angle of about 40°, deep, narrowed towards the base, not bent; a fold or constriction springing from the side next the

pinna a little above the base, almost crossing the cell and curving towards the aperture; margin with a median anterior tooth and three on each side, the last pair often hidden behind the lateral sarcothecæ; back entire, adnate; front of hydrotheca with an external longitudinal ridge, terminating in an elevated pointed tooth over the anterior tooth of the margin (sometimes absent). Hydrothecal internodes with two folds, one opposite the fold of the hydrotheca, the other at the base of the lateral sarcothecæ. Mesial sarcotheca about three-fourths the length of the hydrotheca, adnate most of its length, slightly projecting, terminal and lateral apertures distinct or united. Lateral sarcothecæ divergent, adnate up to the hydrotheca-margin, free terminal portion short, conical, directed forward, terminal and lateral apertures united. Cauline sarcothecæ stout, with open margin, two on the stem at the base of each pinna.

Gonangial pinna generally springing from the basal part of a branch, and bearing only sarcothecæ on about the first five internodes. Corbula large, closed, composed of about nine pairs of broad leaflets, the junction-lines marked by thickenings, which towards the front of the corbula generally rise into free prominent expansions, and which are beset with short, conical, canaliculate sarcothecæ, except at the base, where each gives off a stout process armed with a very broad sarcotheca and a longer and narrower pointed one below it; each leaflet abruptly narrowed on the proximal side near the base, leaving a series of openings along each side of the corbula. A large sarcotheca projecting into the corbula from the basal part of each leaflet.

Colour.—Light-brown.

Hab.—Rottnest Island, Western Australia.

This handsome species was obtained by Mr. A. H. Courderôt, and by him given to Mr. A. J. Campbell, to whom I am indebted for the opportunity of describing it.

HALICORNARIA ASCIDIOIDES, Bale.

(Plate V., fig. 1.)

Gonothecæ in two rows, springing from the bases of the hydrocladia, somewhat pyriform, with the top flattened, and a

very distinct circle of highly refractive granules just below the aperture.

Port Phillip Bay (Mr. J. B. Wilson).

(The gonothecæ have not previously been described.)

Halicornaria superba, Bale.

Dongarra Beach, Western Australia (Mr. A. J. Campbell).

Kirchenpaueria, Jickeli, (modified).

Diplocheilus, Allman.

Azygoplon, Bale, not Allman.

Hydrocaulus pinnate; hydrocladia furnished with median sarcothecæ, but none at the sides of the hydrothecæ; median sarcostyles present which are not provided with sarcothecæ, but communicate with the interior of the hydrocladia by simple apertures in the perisarc.

Gonangia without phylactocarps of any kind, sometimes adnate by one side to a foreign substance.

The genus *Kirchenpaueria* was founded by Jickeli for some specimens collected at Trieste, which, though fragmentary, were sufficiently well preserved to exhibit clearly the peculiarity which induced him to establish a new genus for them, namely, the presence of naked sarcostyles above the hydrothecæ. Another feature which seems to me of equal importance was the absence of the lateral sarcothecæ usually found in connection with the hydrothecæ; I have accordingly included this characteristic in the generic definition.

Among the material forwarded to me by Mr. J. B. Wilson were several specimens of the *Diplocheilus mirabilis* of Professor Allman's *Challenger* Report, in which the soft parts were fairly well preserved, and examination of these readily showed them to belong to Jickeli's genus. The hydrothecæ of *D. mirabilis* bore a striking resemblance to those of the small species which I formerly described as *Plumularia producta*, and afterwards as *Azygoplon productum*. I therefore carefully re-examined the latter species, and although none of the specimens retained the

soft parts, I found the circular apertures through which the naked sarcostyles had been protruded, and which would scarcely have been noticed without a special search, owing to the tenuity of the perisarc around them, and to the fact that their peculiar position rendered it difficult to get a clear view of them. The perisarc of the hydrocladium curves upward to meet the back of the hydrotheca, and the circular aperture is situated in this curved-up portion, nearly vertical to the hydrocladium, so that, whether the latter be viewed laterally or in front, the aperture is turned edgewise to the observer, and is therefore not noticeable, the perisarc being so delicate that the interruption of continuity is only to be seen by careful focussing. However, if a hydrotheca can be found tilted up perpendicularly, the orifice is readily distinguished. In *K. mirabilis* the hydrotheca is formed on the same model, but the perisarc is thicker, and the interruption in it can be easily seen in optical section, as I have shown in Figs. 4-5. The sarcostyles, which are present in most of Mr. Wilson's specimens, are not altogether unprotected, as the perisarc is extended into a slight web on each side of the hydrotheca, which it joins to the pinnule, so that the sarcotheca is to a great extent sheltered in every direction except in front. In Jickeli's specimens the cauline sarcostyles were all naked, but in our two species they are usually provided with sarcothecæ more or less developed; I have found them entirely absent, but it is possible that in those cases they had been broken off.

The gonangia have no distinct marginal ring or operculum, but open by an irregularly circular line of fracture at the summit. Those of *K. mirabilis* are very large, and free, those of *K. producta* are smaller but of similar type, modified however by having one side flattened and adnate to the substance to which the hydrorhiza is attached.

As hereafter mentioned, the special character on which the genus *Diplocheilus* was founded is not really present; there is therefore no reason why the only species should not be transferred to the present genus, where it rightfully belongs. (See *Kirchenpaueria mirabilis.*) The genus *Azygoplon*, Bale, must also be cancelled, as the only species, *A. productum*, is now proved to be referable to *Kirchenpaueria.*

KIRCHENPAUERIA MIRABILIS, Allman, sp.

(Plate VI., figs. 4–7.)

Diplocheilus mirabilis, Allman, *Challenger* Report on Hydroida, part i., p. 48, pl. viii., figs. 4-7.

Hydrocaulus about two to three inches in height, monosiphonic or slightly fascicled, sometimes sparingly branched; stem-internodes long, pinnæ alternate, not close, one or two on an internode of the stem, a hydrotheca on each internode of the pinnæ, joints of stem and pinnæ very oblique. Hydrothecæ nearly parallel with the pinna in their proximal portion, distal part curved upwards, aperture circular, margin free, widely expanded; front wall of hydrotheca deeply inflected immediately below the lip, the inflection forming an intrathecal ridge which extends rather more than half across the cavity of the cell; external sinus caused by the inflection completely filled up with homogenous perisarc. A single sarcotheca below each hydrotheca, fixed, erect, upper portion forming a nearly circular concave shield, facing the hydrotheca. A sarcostyle in the angle between the back of each hydrotheca and the pinna, not provided with a sarcotheca, but partly protected on each side by a narrow web which connects the pinna with the back of the hydrotheca. Cauline sarcothecæ—one at the base of each pinna, and one or two others near it, one (conical) in each axil.

Gonangia large, free, with rounded summit, and irregular wide transverse undulations, no distinct marginal ring or operculum, sporosacs two.

Stems brownish yellow, pinnæ nearly colourless.

Hab.—Port Phillip (Mr. J. B. Wilson); Griffiths' Point (Dr. Haswell); Moncœur Island, Bass' Strait (Prof. Allman).

This species was described by Professor Allman in the *Challenger* Report as the type of a new genus—*Diplocheilus*—characterised by the possession of an external calycine envelope in addition to the ordinary hydrotheca. I have suggested in a former paper* that the supposed external envelope was probably a *thickening* of the hydrotheca-wall in front, similar to that which

* On Some New and Rare Hydroida in the Australian Museum Collection.—Proceedings of the Linnean Society of New South Wales, vol. iii., 2nd Series, 1888.

exists in *Plumularia delicatula* and various other species, and which, present in some forms only of *P. setaceoides*, may attain in them a thickness nearly equal to the inside diameter of the calycle itself ;* and this view of the structure is completely borne out by an examination of the specimens collected by Mr. Wilson. The hydrothecæ are formed on essentially the same plan as those of *Lytocarpus phillipinus* and many other Statopleans ; that is to say, they form a sac, the proximal part of which lies parallel with the hydrocladium, while the distal portion is sharply recurved, the front wall being thereby doubled upon itself so as to form a deep constriction or an intrathecal ridge in front of the cell. In some species—for instance, *Aglaophenia longicornis*—the inflected parts of the wall do not quite meet, but leave a deep open angle on the outside of the calycle-front ; in others, such as *Lytocarpus phœniceus* and *Acanthocladium Huxleyi*, the hydrotheca is more strongly recurved, so that the two parts of the inflected wall come into close apposition and union, forming a completely internal partition.† In *K. mirabilis* a somewhat intermediate condition occurs ; the thin wall of the recurved portion is not brought into contact with that of the proximal part, but the external angle formed by the inflection of the sac is entirely filled up by a solid homogeneous chitine, appearing, as seen in lateral view, as a stout wedge-shaped projection, extending fully half across the diameter of the hydrotheca, from a point immediately below the lip. This ridge, however, is only a thickening of the adjacent perisarc, as may be readily observed in optical section, where the substance of the ordinary hydrotheca-wall is seen to expand gradually into the thickened ridge, which is bounded by a single contour only, proving that it is not an enclosed cavity, but a homogeneous continuation of the perisarc. In precisely the same way the perisarc along the front of the

* Further analogous cases are afforded by the thickening of the stem-internodes in *Obelia geniculata*, the almost complete filling-up of the hydrotheca by perisarc in *Hypanthea* and *Eucopella*, and the thickening of the calycle-wall in *Campanularia caliculata*, so as to give the appearance in optical section of two calycles, an inner and an outer, often differing considerably in form from each other. In most instances the extent to which the perisarc is thickened varies greatly in different examples of the same species.

† In *Halicornaria superba* and its allies the partition is considerably below the aperture, and the mesial sarcotheca continues in union with the front of the hydrotheca up to the margin ; the partition or ridge therefore appears to spring from the sarcotheca, and its homology is not at first sight so obvious as in the species already mentioned.

hydrocladia is thickened at intervals to form those internal transverse ridges which are found in most species of *Plumularia* and its allies. In viewing the hydrotheca in front the inner boundary of the ridge presents a biconcave aspect, or it may be nearly straight in the central portion, except for a distinct median tooth or point. The hydrothecæ are very transparent and colourless, but (in this instance at least) they bear immersion in Canada balsam without shrinkage of the wall-thickenings or distortion of any kind, though the everted circular margins are of such tenuity that they are scarcely traceable in balsam unless exactly in focus.

The cauline sarcothecæ are somewhat variable in number and arrangement, but there appears to be always an erect conical one in the axil of every hydrocladium, with two or three on the front of each stem-internode, the latter being very much of the same character as those in front of the hydrothecæ. I have had for a long time some specimens collected by Dr. Haswell at Griffiths' Point, which consisted only of the basal parts of the stem with bunches of gonangia, and which I now identify as belonging to this species by comparison with Mr. Wilson's specimens. They have no sarcothecæ on the stem, but only apertures; it is quite possible, however, that sarcothecæ may have been formerly present.

The stem-internodes bear sometimes one, sometimes two hydrocladia, the longer ones being mostly found in the older parts of the polypidom and the shorter ones nearer the summit; they are, however, sometimes interspersed. The species appears normally monosiphonic, but the lower part is sometimes slightly fascicled.

The gonangia, which have not been hitherto known, reach about one-eighth of an inch in length, with a few very irregular transverse undulations and no neck or marginal ring.

KIRCHENPAUERIA PRODUCTA, Bale.

Plumularia producta, Bale, Journ. Micr. Soc. Vict., Apr., 1882, p. 39, pl. xv., fig. 3; Catal. Aust. Hyd. Zooph., p. 133, pl. x., fig. 4.

Azygoplon productum, Bale, Proc. Lin. Soc. N.S.W., 2nd ser., vol. iii., p. 774, pl. xix., figs. 1 to 5.

Hydrocaulus about one-third of an inch in height, monosiphonic, unbranched; stem-internodes long, pinnæ alternate, not close, one or two on an internode of the stem; a hydrotheca on each internode of the pinnæ; joints of stem and pinnæ very oblique. Hydrothecæ nearly parallel with the pinnæ in their proximal portion, distal part curved upwards, aperture somewhat oblong, margin free, not widely everted at the sides; a strong intrathecal ridge springing from the front wall of the hydrotheca, a little below the lip, and extending rather more than half across the cavity of the cell. A single sarcotheca below each hydrotheca, fixed, erect, upper portion forming a concave shield facing the hydrotheca. A sarcostyle in the angle between the back of each hydrotheca and the pinna, not provided with a sarcotheca, but partly protected on each side by a very narrow web which connects the pinna with the back of the hydrotheca. Cauline sarcothecæ one (conical in form) at the base of each pinna, and one in each axil, sometimes an additional one on the stem-internode.

Gonangia flattened on one side, by which they are adnate to the substance on which the colony is attached, a few irregular indistinct transverse undulations on the upper side, aperture subterminal, without any distinct marginal ring or operculum.

Colour.—Yellowish.

Hab.—Queenscliff, Williamstown, Portland, Port Jackson.

This species, though closely allied to *K. mirabilis* in its more mportant features, differs from it entirely in its dwarf habit, its adnate gonothecæ, and, to a certain extent, in the form of the hydrotheca, which is here somewhat more recurved, so that the distal and proximal portions become closely united in the front, forming the ordinary intrathecal ridge, instead of leaving a space to be filled up with solid perisarc, as in *K. mirabilis*. The hydrothecæ, however, are rather variable in form, and in some specimens the lip projects strongly, and the angle just below it, along with the constriction which marks the origin of the intrathecal ridge, is filled up by chitinous matter, which in my specimens was evidently not of dense consistence, as it shrivelled on immersion in balsam; indeed the whole polypidom is of fragile texture, and generally shrivels more or less on drying, or on immersion in a

dense medium.* In front view the hydrotheca appears very different to that of the other species, on account of the aperture being of an oblong or elliptic form, due to the lateral margins being erect instead of widely expanded, so that the aperture, though long, is no wider than the body of the hydrotheca, while in *K. mirabilis* the sides are strongly everted, contributing to form the wide circular rim characteristic of that species. The intrathecal ridge as seen in front view is not toothed or pointed at the centre, but has the margin convex or sometimes nearly straight. The mesial sarcothecæ are variable in the extent to which the upper loculus is developed, generally approximating in form to those of the last species, but sometimes being much narrowed at the sides; those on the rachis are not constant in number. The internodes of the stem may bear either one or two hydrocladia.

The gonangia being attached by the whole of the lower side, the aperture is on the upper surface, close to the end, and is formed by the rupture of the perisarc in a circular form; at least, such was the case in all the specimens I have examined except one, which had the orifice partly terminal and partly lateral, with the margin more distinctly outlined than usual. The undulations on the upper surface are so faint as to be scarcely perceptible except in dry specimens.

PLUMULARIA CAMPANULA, Busk.

Marktanner-Turneretscher† states that the *P. rubra* of von Lendenfeld is an unbranched but pinnate form of this species, a conclusion which was to be expected, seeing that their minute structure is identical, though they had not previously been found in conjunction. Busk, however, in his original description of *P. campanula*, mentioned that simple and branched shoots grew together in the same colony, and there can be little doubt that the hydrosoma always commences its growth as a simple shoot, bearing hydrothecæ, that it afterwards gives off pinnate hydro-

* It is worthy of note that in this and other species the terminal or newest hydrothecæ occasionally retain their shape perfectly, while all the older parts of the perisarc are more or less shrunken and distorted.

† Die Hydroiden des k.k. naturhistorischen Hofmuseums, Wien, 1890.

cladia, and finally assumes a branched form. In most *Plumulariæ* the primary form is pinnate, and they bear no hydrothecæ on the rachis; but in species like *P. campanula* there is no difference between the structure of pinnæ and stem until the latter begins to assume a polysiphonic form.

Plumularia tubulosa, n. sp.

(Plate V., figs. 2–5.)

Shoots simple, slender, about one-third of an inch in height, divided by very oblique joints into rather long internodes, each of which bears a hydrotheca at its lower end. Hydrothecæ set at an angle of 40° to 45°, tubular, cylindrical, sometimes slightly bent, twice as long as broad, and free for half their length; aperture plain, the sides slightly and evenly sinuated, lip curved a little outwards in front. Sarcothecæ bithalamic, canaliculate, fixed and stout at the base, one at each side of the hydrotheca (pedunculate), one in front, one midway between every two hydrothecæ, on the same internode as the lower.

Gonothecæ—female, large, pear-shaped, broad, somewhat flattened above, tapering below, with a distinct sub-globular segment at the base of the capsule, and a sarcotheca at each side a little above the base; a circular operculum at the summit, the border of the aperture slightly thickened; male—smaller, with one sarcotheca only.

Almost colourless.

Hab.—Port Phillip Bay (Mr. J. B. Wilson).

Closely allied to *P. campanula*, differing, however, from the stemless form of that species in the much greater proportionate length of the hydrothecæ. It is just possible that it may prove to be only a variety, but so far I have failed to find any intermediate forms, and the difference in the hydrothecæ seems to fully warrant its being regarded, at least provisionally, as a distinct species. Most of the Plumularians in which the hydrocladia spring direct from the hydrorhiza are known to be merely stemless forms of ordinary pinnate species, and probably the present species may prove no exception to the general rule; so far, however, no pinnate specimens have been observed.

The perisarc is ordinarily thin, but in some of the shoots the walls of the hydrothecæ are much thickened. The male and female gonangia were on different shoots; the former seemed rather larger in proportion than those of *P. campanula*, otherwise there was no important difference.

PLUMULARIA FILICAULIS, Pœppig.

Port Phillip Bay (Mr. J. B. Wilson).

The specimens consisted of pinnate and undivided shoots growing abundantly from the same hydrorhiza.

PLUMULARIA PROCUMBENS, Spencer.

(Plate V., figs. 11–12.)

(Trans. Royal Soc. Vic., Vol. II., Part I.)

Since I received the specimens from Mr. Wilson, Professor Spencer has very fully described and illustrated this species (also from specimens collected by Mr. Wilson); I may however add that in a few instances I have found sarcothecæ on the short internodes of the hydrocladia, which ordinarily bear no appendages of any kind. The hydrothecæ are very small, and in proportion to them the sarcothecæ are unusually large.

PLUMULARIA COMPRESSA, Bale, var.

A form differing from the type only in the size, which does not exceed about $\frac{1}{8}$-inch in height, with all the parts small in proportion. Dongarra Beach, Western Australia (Mr. A. J. Campbell). A similar variety occurs in Port Jackson.

PLUMULARIA FLEXUOSA, n. sp.

(Plate V., figs. 6–10).

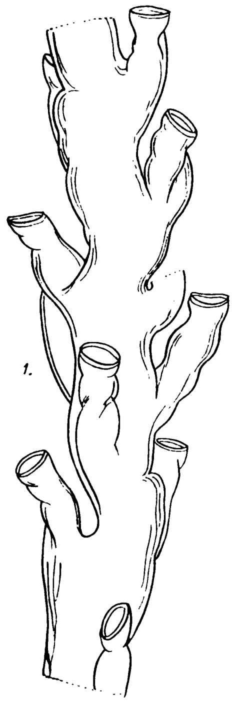
Hydrocaulus monosiphonic, unbranched, about one-eighth of an inch in height, stem very slender, flexuous; pinnæ alternate, each borne towards the upper part of an internode and supporting a single hydrotheca, distal part curving abruptly from under the hydrotheca, widening upwards, generally with a constriction

behind the hydrotheca. Hydrothecæ campanulate, margin entire, slightly everted, rising a little above the summit of the pinna, at right angles to it and the cell. Sarcothecæ bithalamic, canaliculate, with slender bases, one below each hydrotheca, one on each side above it, two in each axil, and one on the lower part of each stem-internode. Gonothecæ 7-8 times the length of the hydrothecæ, ovate, aperture terminal, rather small, somewhat oblique, without internal teeth, sometimes with an elevated rim.

Hab.—Mouth of Snowy River and Cape Lefebvre (Dr. MacGillivray).

This species is very close to *P. pulchella*, of which I at first considered it a variety. So far as the trophosome is concerned, it is distinguished by its very small size and extremely slender stems, which are strongly flexuous, and bear the pinnæ near the summit of the internodes. In *P. pulchella*, on the other hand, the whole structure is much more robust, the stem a good deal wrinkled or annulated, with the internodes straight, very short in proportion to their length, and bearing the pinnæ for the most part about the middle. The form and arrangement of the hydrothecæ and sarcothecæ is the same in both species, except that *P. flexuosa* has a sarcotheca on the lower part of each stem-internode in addition to having two in each axil. The gonothecæ furnish the most important distinction—those of *P. pulchella* are stout with a large aperture directed laterally, and surrounded inside with large smooth teeth projecting into the interior, those of *P. flexuosa* are much narrower in proportion to the length, with a smaller aperture, only slightly oblique, and without teeth. The aperture in some cases only is surrounded by an elevated margin, and the general outline of the gonotheca is somewhat apt to be irregular, showing at times a decided tendency towards a transversely undulated form.

Some fragments from Bondi, which I have hitherto considered a dwarf variety of *P. pulchella*, agree with the present species except in the absence of the inferior sarcothecæ of the stem-internodes, a distinction not sufficiently important to forbid their reference to *P. flexuosa* if the gonothecæ should prove similar to those of that species.



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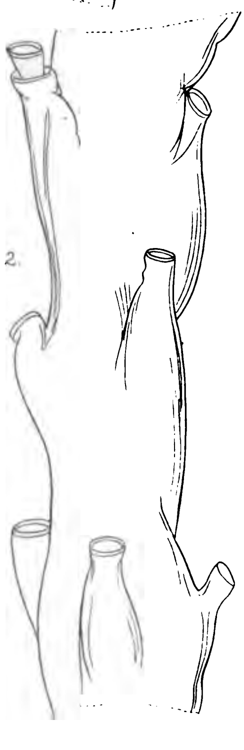

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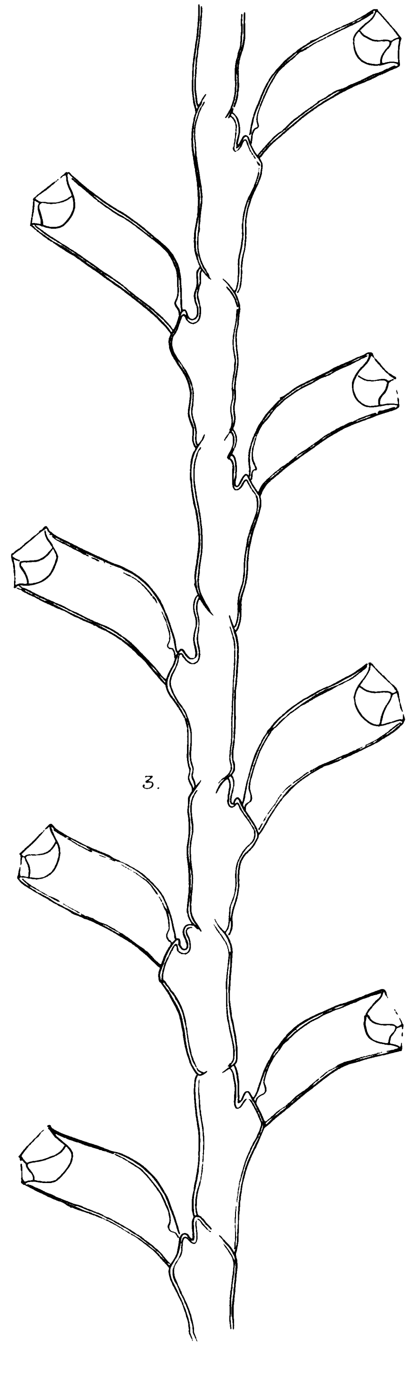

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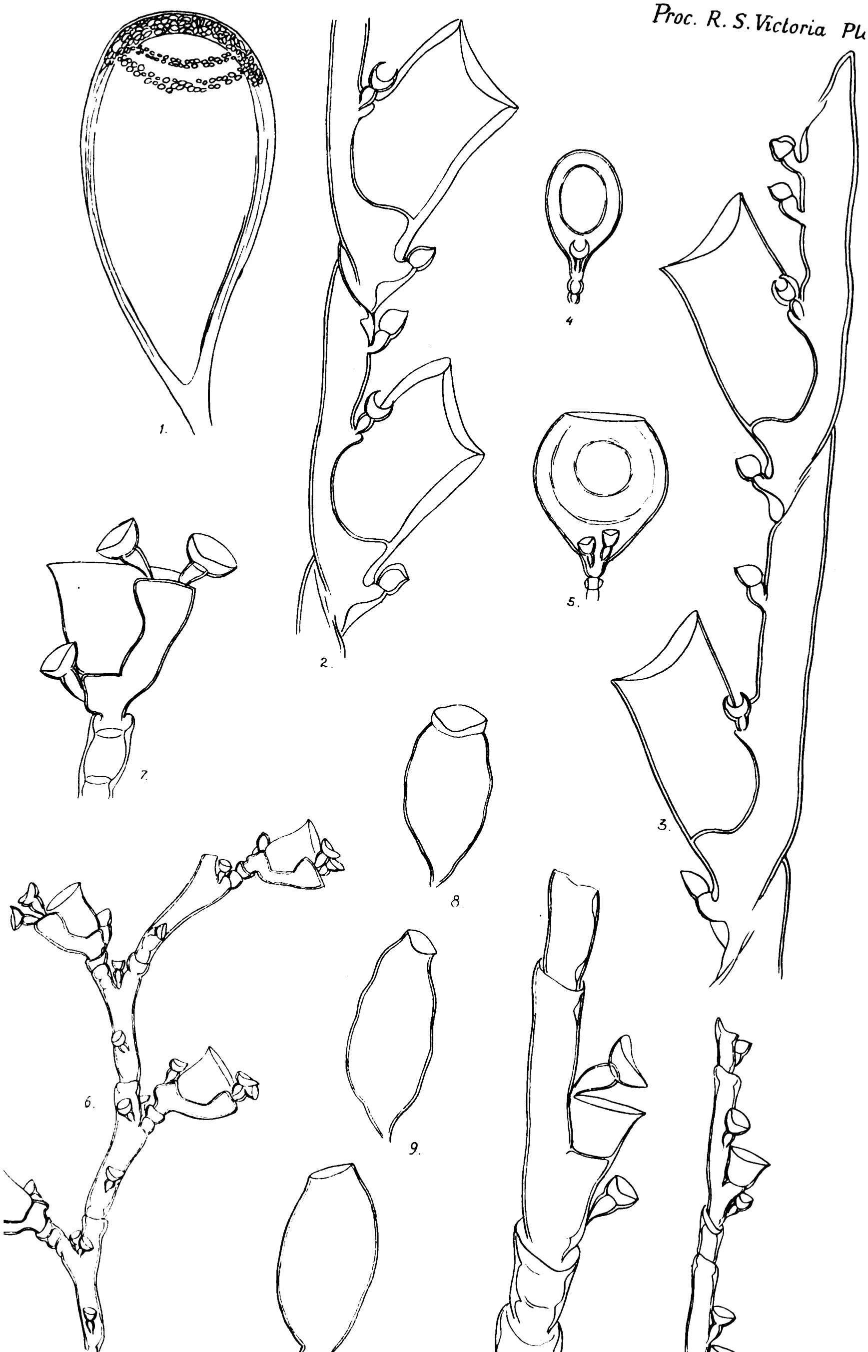
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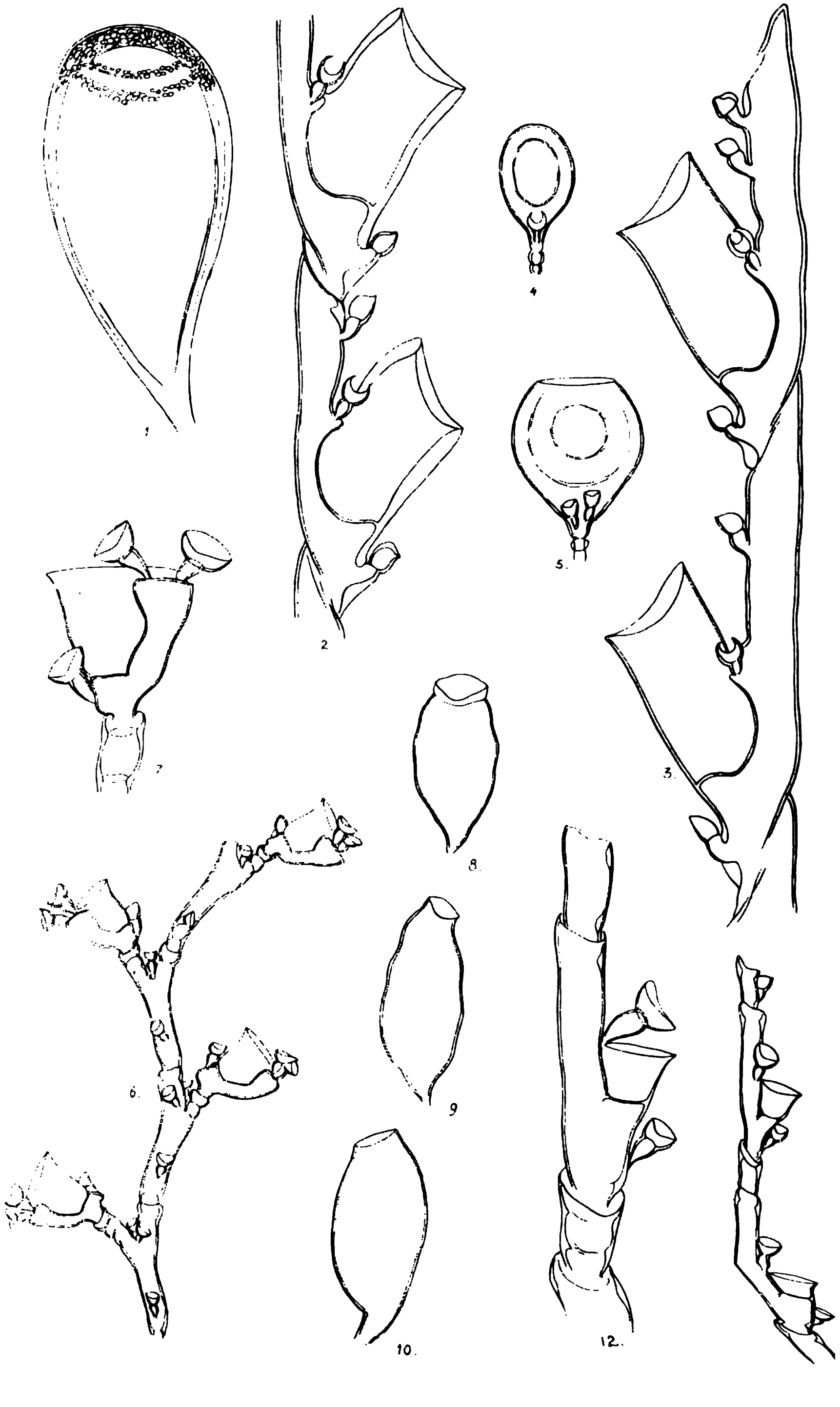
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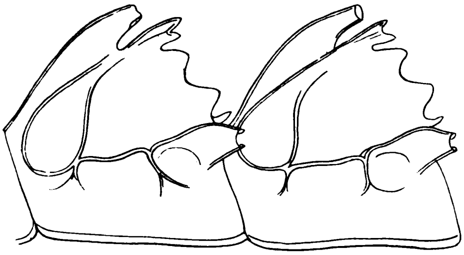

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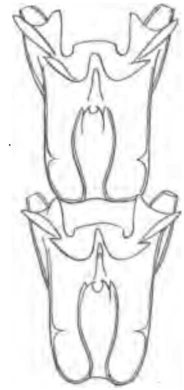

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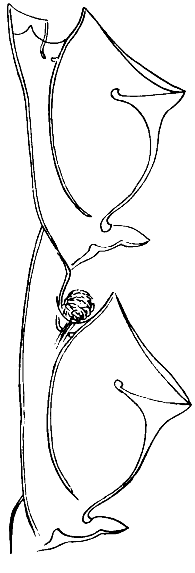

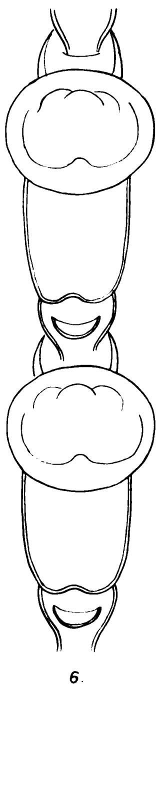

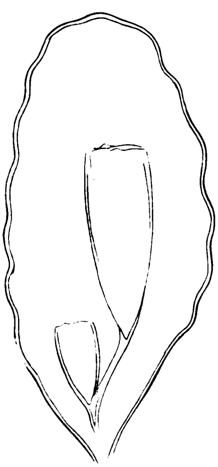

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EXPLANATION OF PLATES.

Plate III.

Fig. 1.—n. gen. and sp. ?, distal portion. × 20.
„ 2. „ „ proximal portion. × 20.
„ 3.—*Campanularia tridentata*, n. sp. × 40.

Plate IV.

Fig. 1.—Gonangium of *Thuiaria lata*, Bale. × 20.
„ 2. „ „ *Thuiaria fenestrata*, Bale. × 20.
„ 3. „ „ *Sertularella macrotheca*, Bale. × 20.
„ 4-5. „ „ *Idia pristis*, Lamx. (From drawings by Mr. Busk).
„ 6.—*Sertularella angulosa*, n. sp. × 40.
„ 7-9.—Gonangia of *Sertularella longitheca*, Bale. × 20.

Plate V.

Fig. 1.—Gonangium of *Halicornaria ascidioides*, Bale. × 40.
„ 2.—*Plumularia tubulosa*, n. sp., thick-celled specimen. × 80.
„ 3. „ „ thin-celled specimen. × 80.
„ 4. „ „ male gonangium. × 25.
„ 5. „ „ female „ × 25.
„ 6.—*Plumularia flexuosa*, n. sp. × 80.
„ 7. „ „ more enlarged.
„ 8-10. „ „ gonangia. × 40.
„ 11.—*Plumularia procumbens*, Spencer. × 80.
„ 12. „ „ more enlarged.

Plate VI.

Fig. 1-3.—*Aglaophenia carinata*, n. sp. × 80.
„ 4-6.—*Kirchenpaueria mirabilis*, Allman, sp. × 80.
„ 7. „ „ gonangium. × 20.

Art. IV.—*The Hatching of a Peripatus Egg.*

By Arthur Dendy, D.Sc.

[Read 13th April, 1893.]

In *Nature* for 17th September, 1891, I briefly described some eggs of the larger Victorian *Peripatus*, which were laid by specimens kept alive by me in the winter (Australian) of 1891. At that time, following previous authority, I identified the species which laid the eggs as *P. leuckartii*. It appears now, however, that the real *P. leuckartii*, at any rate in New South Wales, is undoubtedly viviparous, and our oviparous Victorian species is therefore probably distinct. It may be remembered that in *Nature* for 14th February, 1889, I suggested this probable distinction on account of the remarkable pattern of the skin usually exhibited by the fifteen-legged Victorian form. Further particulars on this subject are given in my "Further Notes on the Oviparity of the larger Victorian *Peripatus*, generally known as *P. leuckartii*,"* and in the literature cited therein. In that paper I also described two embryos removed from eggs which had been laid for about three and eight months respectively. In the latter case I showed that the embryo was possessed of the full number of appendages and was in all respects a perfect young *Peripatus*, differing externally from the adult only in the smaller size and less deeply pigmented skin. On the strength of those observations I claimed to have definitely proved that the larger Victorian *Peripatus* at any rate sometimes lays eggs, and that these eggs are capable of undergoing development outside the body until perfect young animals are produced. I am now able to add some further information.

For some time only one egg (belonging to the original lot, for none have since been obtained) remained in the hatching-box. The shell of this egg had changed to a dark brownish colour, and latterly an embryo had been visible through the shell, coiled up

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* Proceedings of the Royal Society of Victoria, vol. v., p. 27. (Also published in the Annals and Magazine of Natural History, 1892).

inside. The egg was lying on a small piece of rotten wood which rested on the glass floor of the hatching-box.

On 3rd January, 1893, not having opened the box for some days, I made an examination. The egg was in its former position, so far as I could tell, but the shell was split on one side and the young *Peripatus* had escaped. This young *Peripatus* was found lying dead on the glass bottom of the hatching-box, 25 mm. distant from the shell. It must have crawled off the rotten wood and along the glass to the position in which it was found. It was only about 5 mm. in length, so that, even assuming that it moved in a perfectly straight line, it must have crawled for a distance five times its own length.

To the naked eye the young animal appeared of a pale greenish colour. It cannot have been dead for very many days, but decomposition had already set in and the animal was stuck on to the glass on which it lay. It was impossible to remove it without considerable injury, but I ultimately succeeded in mounting it in Canada balsam, and it is impossible, even in its present condition, to doubt that it really is a young *Peripatus*, for the characteristic jaws and claws are well shown. I also mounted the ruptured egg-shell, and found that the characteristic sculpturing on the outside was still clearly visible.

This egg, then, hatched out after being laid for about seventeen months (from about July, 1891, to about the end of December, 1893). I cannot believe that under natural conditions the embryos take so long to develop. They were possibly retarded by being kept in a very cool room. At any rate it now appears certain that the larger Victorian *Peripatus* lays eggs which may hatch after a lapse of a year and five months.

Art. V.—*A New Thermoelectric Phenomenon.*

(With Plate VII.)

By W. Huey Steele, M.A.

[Read 13th April, 1893.]

In text books on thermoelectricity it is usually stated that while an electromotive force may be caused by heating part of some metal, which either in its molecular condition, or in its shape, is not homogeneous or symmetrical, no electromotive force can be caused by heating a homogeneous piece. The experiments of Magnus in his paper on Thermoelectric Currents in *Pogg. Ann.*, 1851, are generally quoted as authority, but the experiments described below (performed in the Physical Laboratory of the University of Melbourne) seem to show that these statements require to be greatly modified. Magnus, using a very sensitive galvanometer, obtained a number of relative measurements of the electromotive force produced when similar wires at different temperatures were brought into contact, and when wires of the same material but different temper were heated in contact. But he got no effect from heating a single wire up to 100° C. But it appears that he had to take great precautions to prevent unequal heating or temper, or an e.m.f. was sure to appear. An important and interesting example of an electromotive force from one metal is described by Mr. F. T. Trouton (*Proc. Roy. Soc.*, 1886), where it is generated by moving a flame along a steel or iron wire slowly enough to make it red hot. The e.m.f., he says, is generated between the part which has cooled through the critical point and the part which is coming to it. This is of varying magnitude. In a recent report of a committee of the British Association to inquire into the phenomena connected with iron at a dull red heat it is stated that on bringing together a bright red iron wire and a cold one, an electromotive force of ·05 volt is generated. Both of these phenomena, but especially Trouton's, probably depend on the great change in the magnetic susceptibility of iron at a dull red heat.

It was in repeating Trouton's experiment that I found that great effects were produced by heating the iron wire steadily. This effect however was soon found to be very arbitrary and irregular, and steps were taken to obtain regular and systematic observations. A couple of yards of very hard iron wire were put in series with a sensitive galvanometer, the junctions of iron and copper being immersed in the same vessel of oil to insure their being at the same temperature and that no thermoelectric effects were generated in them. The iron was stretched into a loop and heated in various ways, such as warmed with the fingers, parts immersed in boiling water, in hot oil, in melted tin both bare and protected with asbestos, heated in a bunsen and in a blowpipe flame, long portions heated in a tube furnace, and a small part was cooled by evaporating ether. In each case some effect was observed, though below 300° C. it was small, about the same order of magnitude as an ordinary thermal junction of silver and copper. Consistent results however were never obtained: if a certain effect were observed by heating part of the wire in a certain way, then on repeating the conditions a different effect would be observed, perhaps greater, perhaps less, and as likely as not of opposite sign. When kept heated steadily the effect was not constant. It increased, decreased, kept steady, changed sign, vanished and reappeared in the most arbitrary way imaginable, and showed no sign of becoming steadier even after being left alone for half-an-hour. Below a dull red heat these changes were slow, but fast enough to keep the galvanometer needle moving perceptibly, but above a red heat the changes were too fast for the needle to follow dead beat, and it was kept continually oscillating. These oscillations were sometimes small, perhaps ten per cent. of the total deflection, while at others the needle was jerked about so widely that one could not even form a mental estimate of the changes of electromotive force, much less make a note of them. I tried various samples of iron wire of different hardness and thickness, from ·2 mm. to a bar 1 cm. diameter. The effect was observed in each case, it being as a general rule more marked in the finer wires than the coarser. The highest effect I observed in iron was about ·002 volt. On passing the wires through tubes, glass or clay, and heating them, very little effect could be obtained.

After working at the iron for some days I treated a copper wire similarly to see if the effect existed in it too, but could not find a trace of it. The copper wire was a thick one, and this was before I noticed the effect greater in fine wire than coarse. I came to the conclusion that the effect was in some way connected with the magnetic property of iron, and for some time confined my attention to it. After a while, however, I tried a fine brass wire, and instantly found the effect marked, about ·0001 volt. As the wire was heated in the naked flame it soon fused. On twisting the ends together and heating the junction ·001 volt was indicated. Platinum wires of ·8 and ·4 mm. diameter gave very small effects, but a very fine wire of ·06 mm. diameter gave ·0001 volt. Copper wire 1·7 mm. gave no effect, as already stated. ·3 mm. gave ·00002 volt, and one of ·14 mm. ·0001 volt. These values were all obtained by heating the wires in a flame, but as all except the platinum fused almost instantly even in a candle flame I had to take steps to protect them. The most obvious plan was to pass them through glass tubes, but at a red heat there seemed to be chemical action between some of the metals and the glass, so the glass tubes were abandoned for clay tobacco pipe stems. Even the finest wires could be heated for some time in these without burning through or fusing.

Gold wire, when heated, presented some interesting peculiarities. The first tried was an alloy of gold and silver, 62 per cent. gold (fifteen carats). It was somewhat fine wire, ·26 mm. diameter. I found the effect well marked, though at first not so great as in iron, but more steady. The effect was not constant, but the changes took place very slowly, so that the galvanometer needle moved dead beat. Repeated heating and cooling the same part greatly increased the effect, this was not noticed in iron. Frequently on cooling the tube I noticed an extraordinary effect. On turning off the gas there were almost immediate, and apparently instantaneous, rises, sometimes of fifty per cent., sometimes as much as one hundred per cent., though only temporary; one of these sudden rises reached ·01 volt. While repeating the experiment the wire fused, and I had to take a fresh piece. On several occasions I found that by shifting the flame back and forward over an inch or two of the wire that there were points which gave a maximum effect, intermediate points giving little or

none. By thus shifting the flame about I occasionally got very large effects, once reaching ·02 volt, at which it was steady for some time. This was by far the largest effect I had yet observed in any metal. I afterwards obtained two wires drawn from standard gold, 92 per cent. gold, 8 per cent. copper, these were about 1 mm. and ·5 mm. diameter. Neither gave any effect when heated up to melting point in a naked flame, and I could get no effect at all by heating the coarser one in a clay tube. On heating the finer in a clay tube moderate effects, *e.g.*, ·0001 volt, were observed. On attempting to draw the hot wire through the tube it parted. On pushing the broken end into the tube again there was an enormously high effect, but before the resistances could be altered it had fallen somewhat, and when the needle had become steady enough to indicate the amount, it was ·3 volt, though I think it must have been quite ·5, but ·3 was the highest I read, and that I can vouch for. On allowing the tube to cool it was found that the wire was stuck. The tube was cracked open, and it was seen that the gold had fused into a lump the thickness of the tube, and about 1 cm. in length. Another wire was heated, and after the flame had been shifted, about ·025 volt was reached, another shift giving ·13 volt. The effect was always much greater after the wire was fused and the ends pushed together. For the most part with gold the effect was temporary, none of those over ·1 volt lasting more than fifteen seconds, though on one occasion a steady ·18 volt was obtained. The effect was nearly always increased by disturbing the system in any way, such as shifting the flame or pulling the wire along the tube. When the junction of the thick and thin wires was heated the effect was much the same as with the thin wire by itself, but as a rule it was greater and more permanent, and with one exception, which was only for a few seconds, it was always in the same direction—the currents flowing from thin to thick. I alternately heated and cooled such a junction, and at last obtained a temporary effect of ·33 volt, which dropped quickly to ·3 and remained steady. After some time I shifted the flame in hopes of raising it, but it fell. On another occasion it increased steadily to ·29 volt and remained steady till disturbed.

In the early part of my work I used the most sensitive galvanometer obtainable—a low resistance, astatic instrument, with

telescope and a scale at some distance. I soon found that there was no necessity for such a sensitive arrangement, as the needle was constantly going off the scale. It was also necessary for me to measure the resistance of the circuit each time it was altered, *i.e.*, each time a wire was fused or broken and had to be renewed. This was troublesome and took up a lot of time, and I soon found it more convenient to use a high resistance though less sensitive galvanometer, which I arranged to give direct readings as a volt meter and save the trouble of reducing the readings. The lamp and scale was at a distance of forty inches from the concave mirror on the needle which formed on the scale an image of a lens with a dark vertical hair-line immediately in front of the lamp, the lens serving to concentrate on the mirror a larger amount of light from the lamp than it would otherwise have received. The scale had 350 divisions on each side of zero. The galvanometer resistance was 7,400 ohms; in series with this I added 2,600 and another 90,000, which could be short circuited, so that neglecting the resistance of the wires under observation I could have a resistance of either 10,000 or 100,000 ohms. The galvanometer was also provided with three shunts $\frac{1}{9}$, $\frac{1}{99}$, and $\frac{1}{999}$ of its own resistance. Now, putting a Leclanche cell of 1·45 volts into circuit with the 100,000 ohms and the $\frac{1}{99}$ shunt I adjusted the height of the control magnet till the deflection was 145 scale divisions. With this arrangement the readings were always very approximately in decimals of a volt whatever shunt was used. Thus with 10,000 ohms and no shunt, 100 scale divisions indicated ·001 volt; with 100,000 ohms, ·01 volt; with same resistance and $\frac{1}{9}$ shunt, ·1 volt; $\frac{1}{99}$ shunt, 1 volt; and with $\frac{1}{999}$ shunt, 10 volts, so that by adjusting two plugs the one instrument would indicate ·00001 volt and measure 35 volts. I found this arrangement very satisfactory. For perfect accuracy the external resistance should have been slightly different for each shunt, but neglect of this caused an error of only two or three per cent., and I aimed at quickly getting the magnitudes of the effects involved rather than a very accurate measure of them. It may perhaps be convenient to those who are not familiar with the magnitude of the ordinary thermoelectric phenomenon to quote a few figures, so that the relative amounts of ordinary thermoelectric forces and those which I am describing may be readily compared.

The table shows the temperatures at which three different thermoelectric junctions will generate various electromotive forces, the cold junctions being at 0° C.

E.M.F.	·0001 volt.	·001 volt.	.01 volt.	·1 volt.	·3 volt.
Lead Copper	60°C	336	1310	4420	7760
Lead Bismuth ...	2	16	150	921	1870
Antimony Bismuth ...	1	9	85	522	1064

The above are based on Professor Tait's results.

Returning now to the phenomenon under consideration, I may say that, in this paper, I am not following altogether the order of my experiments, but am giving all experiments on one metal together, though I frequently left a metal and returned to it again.

In platinum there was apparently an anomalous result. Two unequally thick wires and a very fine one were stretched in series, the fine being between the other two. Heating the junction of the fine and coarsest gave ·0027 volt; while the fine and medium gave ·0007, *both in the same direction;* one would expect that in each case it would be from fine to coarse or *vice versâ.* It may however have been due to different amounts of impurity in the specimens. When the medium wire was heated by itself there was no perceptible result, the coarsest gave ·0001 volt and the fine gave various amounts up to ·0023 volt.

Fine brass wire heated in a tube behaves similarly to iron when heated in a flame, the effect being very unsteady. It is much less sensitive than gold to being disturbed; the highest effect I observed with brass was ·015 volt.

The behaviour of German silver was, in many respects, similar to gold. The effect was greatly increased by repeated heating and cooling, and the changes were generally slow and steady, though occasionally without any apparent cause the changes became great and abrupt, as much as with iron. Like gold too it showed distinct positions of maximum and minimum effects, they being even more marked than in the case of gold. Plate VII. shows the best

example of this I ever obtained, but I could never again get one nearly so good. The time occupied in taking the observations from which it is drawn was about two hours. When the flame was shifted forward a centimetre, the needle crept slowly to the next position, there not being a single oscillation the whole time. For a long time I had been unable to obtain more than ·001 volt from German silver, but on one occasion I found two different parts of a wire, one of which gave ·0014, the other ·0016, giving the same values after several heatings. I then heated them simultaneously and got ·0031, which afterwards increased to ·0042, and after being heated and cooled several times increased to ·0047, the wire then fused. On another occasion, after heating a wire for some time, with little effect, I left the flame alone for a considerable time, and the electromotive force rose steadily to ·0045, and unsteadily to ·0052, and then fell as suddenly as if the wire had parted, but it had not, for on the oscillations of the needle dying out there was still a small deflection.

To examine lead I first of all dipped part of a lead wire into hot oil, but could get no effect. I afterwards melted some lead in the bowl of a pipe and heated the stem so as to make it run along and fill it up. The lead could thus be heated far above its melting point without running away and breaking circuit. On heating this tube the effect was apparent at once, and on irregular heating soon became considerable, ·001 volt. The tube was then heated systematically from end to end, and it was found that there was about an inch towards one end which always gave great results when heated, while at all other parts the effect was very small. After several heatings ·013 volt was observed at this critical point. Though the movements of the galvanometer needle were very slow and generally dead beat, yet, about this part, there were some peculiar effects. On one occasion, on applying the flame to this point, the galvanometer reading rose steadily to 110, decreased unsteadily to 10, and then swung unsteadily between 90 and 10 in such way as to indicate sudden and systematic rises and falls of electromotive force, though the flame was not disturbed and the temperature of the lead was constant, and there was nothing apparent which could have caused these changes. At another time the reading being 30, not very steady, I removed the flame, the reading fell

steadily to 10 and then jerked to 60, after which it gradually decreased to zero. These jerks on the removal of the flame occurred so frequently as to make one of the characteristics of the phenomenon in the case of lead. Sometimes on heating the lead the readings rose gradually from zero, and at others there was no effect for some minutes when a sudden great deflection occurred. Another pipe stem was taken and a lead wire drawn down till it could be pushed along it, and on heating it I at last got ·2 volt. At the time this was by far the greatest effect yet observed. On one occasion after heating the tube in the usual way I removed the flame at a time when the reading was steady at zero. The e.m.f. rose quickly, but not suddenly, to ·07 volt, and then decreased. As a type of the general behaviour of lead I will describe the chief movements which took place in forty-five minutes, during which the flame was not disturbed. After a little preliminary heating the needle began to move and indicated ·02 volt, then reversed and rose gradually to ·17, but decreased to ·16, at which it remained steady for some time. It decreased further to ·1, but rose to ·185 and kept steady at ·18; decreased to ·05, rose to ·1, at which it kept for five minutes, then went on to ·15, and ·18, after which it fell and reversed to ·07, but soon came back to ·1, and on to ·205, fell to ·1, rose to ·15, fell to ·05, but came back to ·2, and again fell and reversed to $-\cdot 05$ for a few seconds only, after which it rose again to ·15; reversed again to $-\cdot 08$, and $-\cdot 1$, and back to ·205, remained steady at ·203 for half-a-minute. It fell again and reversed to $-\cdot 02$, rose to ·1, and again reversed to $-\cdot 13$. The gas was then turned off for the night. There were many smaller motions superposed on the larger ones, but were quite irregular. In spite of the occasional excursions to the negative side, the deflections were on the one side for the great bulk of the time, $-$*ve* and $+$*ve* are, of course, quite arbitrary. The motions were all dead beat except some of the negative deflections, which were so quick and so short that they set up oscillations in the needle. When the gas was lighted again next morning, the system not having been disturbed, there was no effect after five minutes. The flame was then shifted about, but no effect more than ·0005 volt could be got. I tried several other tubes with lead wires passed through them and

found the behaviour much the same in each case, ·15 volt being observed frequently, and ·2 occasionally. It had nearly always been necessary to shift the flame and thus set up irregular heating before the effect could be observed in any considerable degree. To see if the effect could not be obtained from a perfectly symmetrically heated system, I took a fresh tube, and passing a wire along it applied a flame to the middle, prepared to watch it, if necessary, half-an-hour. There was no effect for a minute, the e.m.f. then became manifest and rose quickly to ·035 volt, and fell again to ·03. Then after rising and falling irregularly for a time it soon reached ·13 volt. Forty-five minutes after lighting the readings changed sign but did not get higher than ·05 on the other side. After an hour I began to heat it irregularly, but did not get more than ·15 volt. With lead a very slight cooling of the tube caused the effect to disappear. Merely cutting off the supply of air from the bunsen flame was always followed by a very great decrease, if not a complete disappearance, of the effect, although the luminous flame kept the tube at a moderate red heat. An estimation of the temperature reached inside the tube, made by means of a copper platinum junction with specimens in which I had not been able to observe this other effect, showed that with the bunsen flame 900° C. was reached, and with a blowpipe 1050°. I only used the blowpipe occasionally, generally using an ordinary bunsen flame.

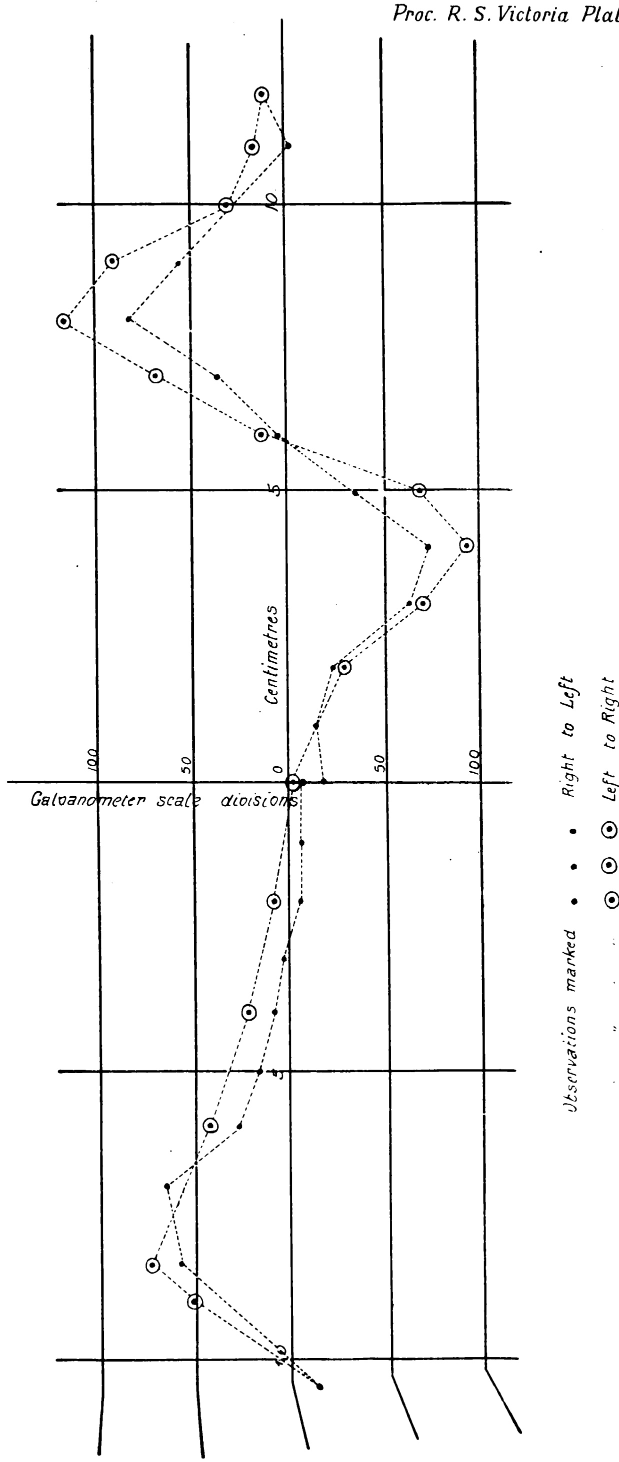
Filling a tube with tin as the first had been filled with lead no effect higher than ·0001 volt was observed for half-an-hour either by steady or irregular heating. At last there was a large and sudden swing of the needle and on its coming to rest it indicated ·15 volt, remaining between ·12 and ·15 for several minutes. Various parts of the tube were heated, and as in the case of the first lead tube there was one point in particular which gave great effects. After leaving it for a couple of days and again applying the flame to this point ·3 volt was indicated almost at once, and for half-an-hour from ·28 to ·31 volt was maintained, only once did it fall to ·21 but instantly rose again. While at its height the gas was turned off. There was a steady and very slow fall, ·01 volt still remaining after ten minutes. The gas was lighted again and ·28 was soon indicated again.

Several other tubes were filled with tin and heated, and with one exception all gave from ·1 to ·2 volts, from the remaining one only infinitesimal results could be obtained. The changes of e.m.f. were much slower in tin than in lead, but it was very sensitive to the flame being shifted along the tube, a few millimetres of shift sometimes causing a great variation in the galvanometer reading. There were no abrupt changes as in the case of lead on removing or lowering the flame. A tin wire (alloyed with lead) when put through a tube and heated behaved similarly to tin and lead, ·16 volt was obtained from it.

I could not get a tube filled with zinc in the same way as I had filled others with lead and tin, but I managed to get one filled by exhausting it while the end was dipped into a crucible of melted zinc. The highest e.m.f. I observed with this was only ·00035, but that was partly, if not wholly, due to the hot junction of the zinc and copper, as the tube of zinc was very short. I afterwards got some zinc wire and passed it along a tube and heated it. There was no result at first, and the wire fused and broke circuit as the diameter of the wire was much less than the bore of the tube. When the ends were pushed in and contact renewed ·05 volt was indicated, but it quickly fell to ·004. On shifting the flame there were various smaller effects, but after cooling and heating several times ·2 volt was at length reached, the behaviour not being in any way characteristic. At a time when the e.m.f. was ·01 and falling slowly I turned off the gas. It fell somewhat faster, though still slowly, and after some minutes, when the tube was cool enough to be held in the fingers, ·006 volt was still indicated. The temperature of the zinc could not have been over 200°.

As already mentioned I had examined copper to see what effect could be obtained from it and had only reached ·0001 volt. After obtaining such high effects in other metals I returned again to copper, using the finest wire I could get, this was ·16 mm. diameter, and silvered, but the silver disappeared almost instantly on heating. After a little irregular heating, ·001 volt was reached, the changes being very slow, and oscillations of the needle being scarcely perceptible. After some time, however,

than in iron in which it is very high. The metals in which I observed the highest effects are not necessarily those in which the effect is really highest, for I examined some for weeks and others only for a few minutes. Most of the time was spent over iron, lead, and gold (ninety-two per cent.) The purest metal I used was silver, one of the specimens being absolutely pure, and with this the effect was very small. The effect however cannot be altogether due to impurity, for with alloys the effect was not more marked than with moderately pure metals.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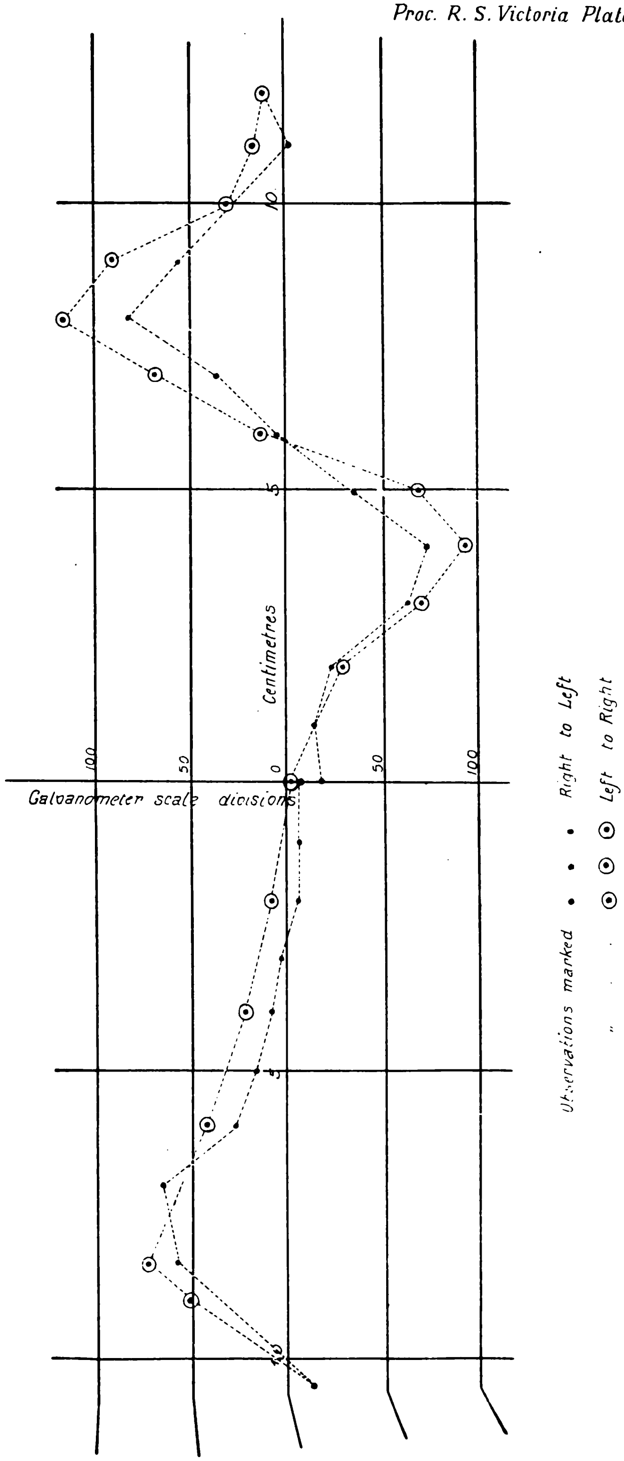

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Art. VI.—*Glaciation of the Western Highlands, Tasmania.*

(With Plate VIII.)

By E. J. Dunn.

[Read 8th June, 1893.]

During the month of October, 1892, professional work took me to the high rugged region surrounding Lake Dora, and there I had the satisfaction of discovering glaciation in its various developments and on an extensive scale. The salient features were made known at the time through the press, but as further particulars may be acceptable, a sketch plan has been drawn of the locality, and further data are appended.

Position, etc.

Lake Dora lies in a direct line about due east from the township of Zeehan and twelve miles distant, but the track between the two points is quite twenty-five miles long, and very difficult to traverse. Lake Dora is about 2,500 feet above sea level. The high tract of country over which glaciation occurs is shown on the plan on the smaller scale, the area more carefully examined is shown on the larger scale plan.

Geology.

This region is occupied by two principal rock formations, the older or schistose series is usually highly inclined, consisting of arenaceous, argillaceous and conglomerate schists; the schists are covered unconformably by massive sandstones, quartzites, cherty and quartzose conglomerates, belonging, apparently, to the Devonian age and corresponding to the Devonian conglomerates of Victoria. Most of the hills and ridges on the highlands are of the Devonian series, the schists occupying the hollows and valleys. The schist appears to be more readily worn down than the Devonian beds, hence most of the tarns appear to be on the former rock, or rather scooped out of it.

Physical Aspect.

The whole region consists of rugged rock-strewn mountains bare, except where sheltered sites have encouraged a forest growth; tarns are dotted about at many different altitudes, from the tiniest pools up to lakelets some miles in length. There is an absence of level land except where a small valley or tarn has been filled with peaty soil, on which the "button-grass" flourishes. Altitudes range from 1,800 to 3,800 feet above sea level over this tract.

Moraines.

The first evidence met with of glacial action was at the outlet of the gorge, where Lake Rolleston stands; this is an excellent example of a terminal moraine. From the level of the lake the morainal matter rises to an elevation of 150 feet on the east side, and for 250 feet on the west side, the whole consisting of a confused mass of angular, sub-angular and partly rounded boulders and blocks from a few pounds to masses of more than 100 tons in weight; this extends over several hundreds of acres. Enormous blocks project above the mass at intervals, while the east edge of the moraine is fringed with a very remarkable curved line of giant stones; they commence at the large one named "The Scout" on the plan, and they fringe the moraine for considerably more than half a mile, running in a northerly direction. Feeders to the glacier of which this moraine is the relic came in further northward from the country to the west and north-west of Lake Rolleston, and morainal matter occurs as marked on the plan. It would appear as though the glacier did not extend much further down the valley, but as though the end of the glacier became melted where the morainal matter now stands, and this continuing for ages caused the enormous accumulation of rocky material to take place. The whole of the moraine apparently consists of *débris* from the hills west of the lake (Rolleston), and is very largely made up of cherty conglomerate (Devonian). An examination of the individual blocks shows that one or more sides have been subjected to a planing action by which this intensely hard pebble-studded rock has been worn down and sometimes even polished. Portions

of the moraine consist of stones and blocks thrown loosely together, the interstices open; in other portions, the interstices are filled with fine material.

Another well marked moraine extends in a southerly direction from Lake Ruby (a small tarn in a gorge under a precipice 280 to 300 feet in height) down the course of Limestone Creek. The material, arrangement, etc., are very similar to that of the Lake Rolleston moraine. In both cases the surface of the moraine is of the most rugged nature.

Erratic Blocks.

Scattered over the surface all round Lake Dora on the hill sides, and even on the tops of hills 300 feet above the level of that lake, are blocks of stone, from small boulders up to heavy masses many tons in weight, that have been transported, in some cases, for miles by ice from their former sites to their present positions; all the morainal matter was thus transported. Some of the more conspicuous examples have been especially named on the plan. Scarcely any of them, but if carefully examined, show unmistakable evidence of having been ground, planed, striated, or polished on some portion of their surfaces. There is a great sameness of material, all of which is local and derived within a very few miles' distance. Some of the large blocks have been split since they reached their present position. Odd blocks of hornblendic rock occur of small size, they probably are derived from masses intruded through the Devonian rocks. Many of the erratic blocks are of great size, and some probably weigh hundreds of tons.

Planing, Scoring, and Polishing.

Planed and scored surfaces are features inseparable from glacial action, and these are most abundantly present over this region. On the western side of Lake Dora the rocky hillocks are planed down, scored, and striated in a beautiful manner, and right up the valley westward from Lake Dora this same action is exemplified on the rounded dome-like rocky projections of schist. To the east of Lake Dora, at the site marked on the plan, there are splendid examples of grooving, etc., both on the sides and

floor of the rocky knoll. All the sides of the hills to the east from Lake Dora leading down to the valley of King River, are abundantly planed, scored, striated, and polished, the latter especially where the beds consist of quartzite rock; even to the top of the hills, some 300 feet above the level of the lake and on the east side, these features extend, striations and polished surfaces occurring to the very crest of the hills. By means of the striæ it is easy to see the direction in which the ice mass moved, for the great glaciers, which at Lake Dora must have been at least 400 or 500 feet thick, moved continually outwards from where the accumulation of ice was greatest. Studded as this ice was with small and great angular blocks of conglomerate, etc., it resembled a huge rasp, which, with irresistible force, filed down, rounded off, planed and scored the surfaces they came in contact with, and also registered in a most durable manner the course in which they were travelling. About Lake Dora the striæ point in many different directions, and it appears as though over this tract there must have been a very thick covering, the pressure of the great mass above compelling the ice to travel in different directions, even up the sides of hills, for the hills on the east side of Lake Dora are striated and scored up steep faces in the direction of their crests and over their summits.

About the best example of what such a great ice-rasp can accomplish is shown at Moore's Shoulder, named after my friend, Mr. T. Moore, who was my comrade and guide in this wild region. At this site a great glacier throughout a vast period must have been deflected around this projecting angle of rock; the result is marvellous, for the intensely hard Devonian conglomerate has been planed, rounded, scored, and polished in a manner that baffles description; the ice marks are noticeable high up the hill sides. Probably at this point the ice was of great thickness, in fact it appears from the scorings, etc., that a great volume of ice hundreds of feet thick covered the whole of this elevated region.

The bed-rock over this region showing such abrasions, etc., it is natural to expect that the moving blocks and boulders which, set in ice, formed the teeth of the rasp, should also equally bear evidence of the work they did, and such is abundantly present, for a large proportion of both great and small rocks and boulders in the moraines are ground down, striated, or otherwise bear

testimony to the forces they have been subjected to. Many of the small pebbles detached from the blocks of Devonian or schistose conglomerates are remarkably ground down, polished, or striated. Some of the pebbles from the Devonian conglomerate are sheared in a remarkable manner; this was done while in their parent mass, the glacial markings have been added since. Curiously enough, at Prince Albert, in Cape Colony, sheared pebbles of precisely similar character occur in the older glacial conglomerate (Dwyka conglomerate) of that region that also show glacial markings, and they, too, are derived from a conglomerate of supposed Devonian age.

Tarns.

Lakelets from several miles in length down to mere ponds are met with throughout these highlands; they occupy rock-basins that the ice mass ground out where the bed-rock happened to be softer than usual. It is noticable that many of these basins have the longer axis in the direction of the strike of the rock, and they appear to occur most frequently on schist country. Nowhere do these tarns appear to be more than a few feet deep, they occur at many different altitudes. The outlets are sometimes over bare bed-rock, in other cases morainal matter dams the water back. Small rocky islets dot some of the tarns, and on them and around the edges of some of the tarns ti-tree and other small trees grow, greatly enhancing their beauty. Now that the flexibility of ice masses is well understood it is easy to understand how such rocky basins could be eroded.

Extent of Glacial Action.

It appears highly probable that the central highlands around Lake St. Clair, and in fact the greater portion of the island above the 2,000 feet level should also contain evidences of glacial action if searched for, and remains in abundance may be expected in the higher country east of Lake Dora.

Age.

There are no direct evidences by which the age of this glaciation can be determined; so far as the appearance of the moraine,

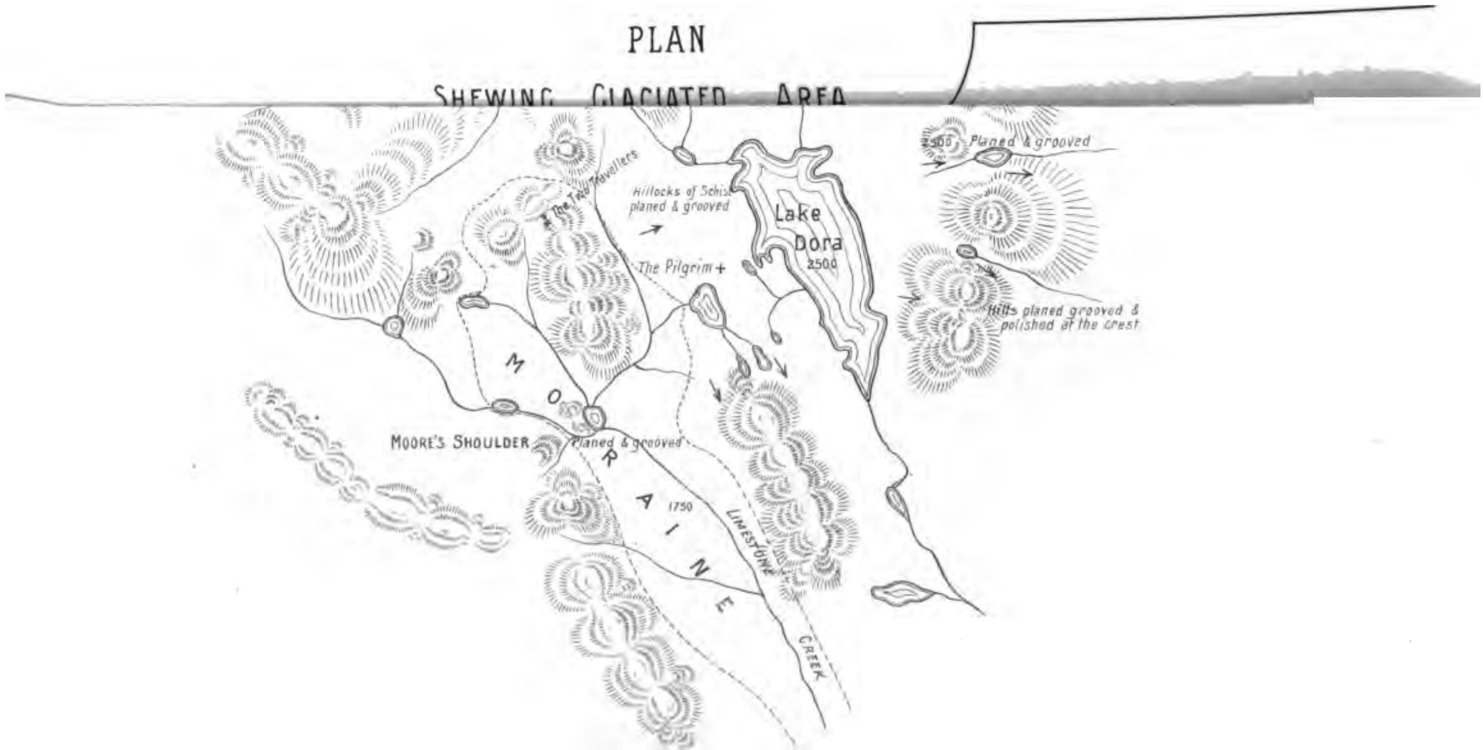
erratic blocks and scored and planed surfaces go, it might have taken place only a few years ago; in some places where the peaty material can be stripped off the abraded surfaces, the face of the rock is as fresh-looking as though the work had been done but yesterday. I do not consider this glaciation could have been older than of tertiary date, and it may very well be recent in age.

Glacial Conglomerate.

Quite distinct in character from the above, and differing entirely in age, origin, and method of deposit, is a remarkable conglomerate that occurs on the south side of the track between Mt. Reid and Moore's Pimple, and about equidistant from each; the site is marked by a shallow hole, and it is 3,000 feet above sea level, high above the observed morainal deposits, etc. The conglomerate consists of a great variety of sandstones, igneous rocks, shales, etc., nearly all well rounded and also beautifully striated; the pebbles and boulders are of non-local origin, unlike the morainal matter above described, and it rests upon Devonian sandstones. There is a marked similarity in the nature of the cementing material, and in the character of the embedded pebbles and boulders, to the glacial conglomerate found at Wild Duck Creek, Victoria, and to the Dwyka congolmerate of South Africa, and they probably all belong to a very ancient epoch, either near the close of the Palæozoic period, or else the commencement of the secondary era. This particular outcrop is, apparently, of no great thickness, and not very extensive, but further search should discover more such outcrops, and their relations might eventually be determined as regards the older Devonian series, and also the more recently accumulated rocks.

PLAN

SHEWING GLACIATED AREA



R. Wendel lith. Melb.

Art. VII.—*Further Note on the Glacial Deposits of Bacchus Marsh.*

By Graham Officer, B.Sc., and Lewis Balfour, B.A.

[Read 8th June, 1893.]

The immediate object of the present note is to correct a mistake in our investigations of the Bacchus Marsh glacial deposits, the results of which were embodied in a paper read before this Society last year. In that paper we claimed to have shown that there were two distinct tills at Bacchus Marsh, separated by the so-called Bacchus Marsh sandstones, and that the upper of these rested on the denuded surface of the sandstone. It is to the latter point that we desire to draw attention.

Our conclusions in this respect were principally drawn from the consideration of sections at a small quarry on the Korkuperrimul Creek. We here described till overlying the sandstone, and a granite boulder over a yard in diameter together with an accumulation of smaller erratics as being jammed into the broken surface of the sandstone.

Having since traversed a good deal more ground without seeing any further evidence of such a state of things, we investigated the matter further, with the result that we now find that the supposed till overlying the denuded sandstone is really a "wash," containing striated stones, and derived in part, at least, from an outcrop of a deposit a little above the quarry. The broken sandstone is due to weathering and a certain amount of rock movement. The granite boulders lie embedded in a matrix of clay which is really intercalated with the sandstones, but looking very much at first sight as if subsequently injected. There are several thin clay bands besides this running through the sandstone, and in these bands small stones of the kinds met with in the till occur. Several we found bore glacial striæ. One of these stones was six inches in diameter. About the line of junction of the largest of these bands, both the sandstone and the clay are remarkably

contorted, and the whole are inclined besides at about thirty-five degrees E.S.E.

There can be no doubt that the clay bands containing the stones and boulders are of glacial origin, in part at least, and that the larger boulders at any rate have been transported by ice, but by floating ice or land ice? It must be said that the stratified nature of the clay bands points to floating ice as being the transporting agent. In the "pocket" containing the large granite boulder we have noted at least three varieties of granite, a boulder of gneiss, and others of quartz-rock, clay-slate, etc.

The sandstone, which is of a massive type, contains *Gangamopteris* in abundance in certain zones. It passes upwards into a bed of more or less clayey nature, indistinctly, if at all, stratified, and bearing boulders and smaller stones. One well rounded boulder of granite measured eighteen inches in diameter. This deposit is overlaid by shales, and fine-grained, argillaceous, well stratified sandstones.

Consistently with our former idea we described a mass of till occurring on the Korkuperrimul Creek, opposite Bald Hill, as being banked up against sandstone. It is really overlaid by sandstone. At the large quarry on Bald Hill the sandstones are seen to be overlaid by a bed which is very rudely, if at all, stratified, and containing small stones scattered irregularly through it. The bedding planes of the sandstones appear contorted along the line of junction, but it is possible this appearance may be due to weathering.

At another small section we described before on the creek, the till is seen underlying tumultuous looking sandstones. The latter bear a few odd stones, several of which we found to be glaciated. A good deal of faulting has taken place here.

Considering the sections exposed on the Korkuperrimul Creek in this locality, we get a succession as follows :—

(1). Till containing a great deal of rock material.

(2). Stratified clays or shales.

(3). Sandstones containing intercalated bands of clay bearing boulders.

(4). A somewhat clayey unstratified deposit, which does not seem to contain so many stones as the bottom deposit.

(5). Shales and fine-grained well stratified sandstones.

A section exposed on the Lerderderg River, about two miles above Darley, shows unstratified clay containing irregular and lenticular bands of hard coarse sandstone, associated with well stratified fine glacial clays. Striated stones and boulders are very abundant through this, and are, as a rule, exceptionally well scored. One of these boulders, a hard blue slate, is five feet six inches long, three feet six inches broad, and a depth of two feet is exposed ; the surface is well scored in a longitudinal direction, though cross striæ occur also. Several other boulders at this section are over two feet in diameter. Though stones occur in the stratified parts yet they are not nearly so abundant as in the unstratified. It is worth mentioning, as illustrating the tough and tenacious nature of the unstratified till, that a farmer resident in the locality, in course of conversation with us, remarked that he had never come across such an unsatisfactory material to work. In constructing a race he had occasion to pass through some of it, which proved very obstinate to the ordinary methods of excavation. Blasting had hardly any effect, and he said the only way to deal with it was to knock it away bit by bit with a hammer and a gad.

We traced the till on to the crest of a spur of the Lerderderg Ranges at a height of about 1000 feet above sea-level (aneroid reading). At one place on the flanks of these ranges, where we could actually see the junction of the till and the Silurian, we found the latter well scored and grooved. In the striated rock surfaces described in our last paper, the striæ and grooves were N. and S., being parallel to the strike of the rocks. In this case the direction of the striæ and grooves is W. 10° N. and E. 10° S., almost at right angles to the strike. In the former case the grooving and moulding was more marked and may be compared to grooves made by a gouge working with the grain of a piece of wood, while in the latter instance the appearance is somewhat similar to that made by a blunt gouge working across the grain

of a piece of wood of uneven texture, now working fairly smoothly, now catching in a harder band, wrenching a piece out, and again proceeding evenly. An indication of the direction of the ice can be thus obtained. In this case the ice appears to have come from ten degrees south of east, but it would be unwise to infer much from this one instance, especially as there is abundant evidence to show that the Silurian rocks have undergone considerable movement since this ancient ice-age.

Wherever we have seen the junction of the till with the Silurian, the former has always been intensely hard and unstratified, and the latter invariably grooved, smoothed, and striated. These are facts, which, in our opinion, point to one conclusion, viz., that the lowest member, at least, of the glacial series is morainic, due to the action of land ice, of the former presence of which we have unquestionable evidence in the *roches moutonnées*. It will have been seen that the Bacchus Marsh sandstones must be considered as part of the glacial series—a conclusion to which our friend, Mr. Brittlebank, has also come independently of us. As the only fossils obtained so far are plant remains, a fresh-water origin for them is indicated, and it is reasonable to suppose that these sandstones were deposited in a glacial lake in which floating ice drifted. The clay bands in the sandstone may perhaps have been formed by subglacial material carried into this lake by streams. Any floating ice would be drifted with the currents and drop their burdens occasionally in the accumulating silt. Such a lake may have been almost an inland sea. The vast size attained by glacial lakes in America during the last ice-age is well known. The alternation of boulder beds with plant-bearing sandstones is only what would be expected on the astronomical theory of ice-ages.

POSTSCRIPT.

Since reading the above paper we have discovered several beautiful examples of *roches moutonnées*, near Coimadai. The smoothed and grooved surfaces can be traced right beneath hard unstratified till. There is also good evidence to show the direction the ice took at this locality, viz., from S.S.W. to N.N.E. These are by far the best example of *roches moutonnées* we have seen in

this district. A detailed description we must leave for a future paper.

Among the fossil plant remains we have discovered in the Bacchus Marsh sandstones, what Sir F. McCoy thinks are probably *Schizoneura* are by far the most abundant. Sir Frederick has also determined the genus *Ptilophyllum*, being the first occurrence of this genus in Victoria. He has described it under the name of *P. officeri*. Several other forms are awaiting identification. They all come from the Schizoneura bed—a thin clayey band about four inches in width. The horizon is apparently above that of the *Gangamopteris* beds.

Sir F. McCoy's description of *Ptilophyllum officeri* is as follows: "Pinnæ about one inch wide; pinnules about eleven in one inch, nearly at right angles to rachis, with coarse, unequal, longitudinal striæ; width of pinnules about half a line, one line apart; rachis about one line wide."

Art. VIII.—*Notes on the Trawling Expedition off Lakes Entrance.*

By T. S. Hart, M.A.

[Communicated by Dr. Dendy, 13th July, 1893.]

Trawling operations were commenced at the end of last April off Lakes Entrance, with a view to obtaining the Government bonus and establishing the industry. The boat obtained was the s.s. *Swansea*, of forty-one tons, twenty-two horse-power. The trawling apparatus consisted of two trawl-heads of iron, connected by a beam above and a ground-rope below, a net being attached to the beam and ground-rope, and ending in a bag with a flap to prevent fish escaping. The trawl-heads consisted of an iron bar, bent so as to form two straight pieces diverging at about thirty degrees, and connected by a curve at the front. At the sharp angle the ground-rope was attached. One of the straight pieces formed a sliding surface, and at the highest point the beam was attached, the tow-line was fixed a little above the middle of the curved part. The trawl-heads in use at first weighed about 180 pounds each, and the beam was about forty-nine feet long, and eight inches in diameter; the ground-rope being about double that length. The net had a mesh of about two inches for the greater part. When I reached Lakes Entrance on the evening of 1st May, they had been out once or twice and not caught much, and were putting in a lighter beam, about six inches in diameter. After this was done and the sea had become a little calmer, a start was made. The trawling apparatus was carried, when not in use, along the port side, and lowered and raised there, the tow-rope being brought round to the stern after it was lowered. The raising and lowering took about two hours, owing to there being only one winch on board, and the side of the boat being obstructed by railings and other things. It was stated on board by the men who were engaged as experts in trawling, that it should only have taken about twenty minutes with proper appliances and arrangements. The time the net was left down varied from four to eleven hours.

The steamer was not sufficiently powerful to tow the net at a proper speed, the speed attained at one time being only one mile an hour; while on one occasion it was found that the steamer could scarcely manage to turn with the net, an hour being spent in turning round.

The plan of operations was to fish near the entrance, running in early in the morning to send up the fish to Melbourne. The ground trawled over extended from about fourteen miles west of the Entrance to opposite Lake Tyers. The depth of water was about twelve to fifteen fathoms, once reaching twenty-five fathoms.

The fish caught were chiefly Flounders, Flathead, Gurnet, Sandcod, Skate, a few Sole, and a fish said to be well known in Sydney though not in the Melbourne market, for which they had no name. At first sight the latter were thought to be young Schnapper. Owing to the coarseness of the net many small things could escape, and as the net in the raising was for a long time almost at water level they had good opportunities of doing so. Starfishes, Crabs, and other animals could frequently be seen walking off as the net was brought up to the surface. After some days it was decided that the trawling apparatus was too heavy for the boat and must be considerably lightened. They therefore decided to cut ten feet off the beam, put on lighter heads of about forty pounds each, and alter the net accordingly. These alterations would take time, and as the weather had set in rough I decided to return on Monday, 8th May. When on shore I spent the time in searching for anything that might be thrown up, but the beach was very barren. Inland there also appeared to be very little to be found.

I have to express my thanks to the Royal Society for defraying my expenses on the expedition; and to Dr. Wollaston (the Secretary for Trades and Customs), Captain Anderson, Messrs. Hill and Son (the Melbourne agents for the owners, Messrs. Murray and Co. of Sydney), and Captain MacArthur of the *Swansea*, for their assistance in making the arrangements, and for granting me every facility in obtaining specimens.

Dr. Dendy says of the *Sponges* collected :—"There are about twenty species, including *Cavochalina bilamellata*, *Halisarca australiensis* (growing on *Boltenia*), and one calcareous sponge, *Leucilla saccharata*. The remainder appear to be nearly all

common forms, closely resembling if not identical with those of Port Phillip Heads."

Of the *Polyzoa* Dr. MacGillivray gives the following list:—*Cellaria gracilis*, *Beania magellanica*, *Membranipora pyrula*, *Steganoporella magnilabris*, *Adeona grisea*, var., *Adeonellopsis mucronata*, *Hipporhoa divaricata*, *Schizoporella triangula*, *Porella marsupium*, *Cellepora foliata*, *C. mammillata*, *C. albirostris*, *Smittia oculata*, *Retepora monilifera*, *Crisia acropora*, *Hornera foliacea*. He says "There is nothing new among them, but the specimens of *Cellepora foliata* and *Steganoporella magnilabris* are unusually good, as also is that of *Adeonellopsis mucronata*. There may be an additional species among the smaller *Celleporæ* but the genus, which is an exceedingly difficult one, is not yet completely worked out."

Other specimens were:

Hydrozoa.—One species.

Alcyonaria.—Two species.

Echinodermata.—Two species of Ophiuroids; one species of Crinoid (*Antedon*); two species of Echinoids (*Strongylocentrotus erythrogrammus* and another). All appear to be common forms.

Worms.—Several tubicolous Annelids, chiefly *Filograna*, and a number of worms living in the sponges.

Crustacea.—About eight species of Crabs, including large Hermit crabs, living in shells of *Voluta fusiformis* and *V. undulata*, and another species in a shell of *Cassis*, and also very large specimens of *Ibacus peronii*.

Mollusca.—On shore, thrown up, *Pectunculus flabellatus* and a few other species all much worn by the surf, including *Triton* sp. and *Potamides* sp. Inside the entrance on the mud banks a species of *Modiola*. Dredged from the bottom, *Pecten laticostatus* and another species of *Pecten*, *Modiola* sp., *Siphonalia* sp., *Voluta fusiformis*, *Crepidula* sp., and empty shells of *Voluta undulata*, *Crassatella kingicola*, *Pinna tasmanica*, *Ostræa* sp., and *Cassis* sp.

On the shore of Lake Bunga, I found a few empty shells of *Bulimus atomatus*.

Tunicata.—One compound Ascidian.

ART. IX.—*Some Statistics showing the extent of the damage done to members of the Medical Profession by the abuse of Alcohol.*

By JAMES W. BARRETT.

[Read 13th July, 1893.]

A very valued friend of mine stated some time since his conviction that in this colony, and up to date, alcohol was the causal agent in effecting the physical and moral ruin of about twelve per cent. of the male population with whom he was acquainted. As he is a highly cultivated man this proportion would be under that obtaining for the community in general. I thought his judgment was biased and told him so, but set to work to find what data were available for the purpose of ascertaining the accuracy of his opinion.

The only feasible plan appeared to be the tracing of the career of a number of people I had known for periods as lengthy as possible, and the estimation of the number whose health or whose prospects in life had been distinctly injured by the abuse of alcohol. If, however, the conclusions were to be of any value the careers of everyone I had been acquainted with must also be followed, and not simply of those whose morbid habits brought them into notoriety. In order to do this it ultimately became necessary to limit consideration entirely to members of the medical profession graduating at the Melbourne University, because it then became possible to make calculation on the whole body of graduations in the medical school, and the fallacy just referred to was eliminated. The objection to the method is that it takes account of the habits of men in one occupation only —an occupation, which, by reason of its exhausting and irregular character, gives a strong filip to moral decrepitude.

In the *University Calendar* for 1881-82 there are fifty-six Bachelors of Medicine on the list, of whom forty-three may be classed with Cæsar's wife as regards the abuse of alcohol. Of the remainder, twelve, or about twenty-one per cent., were decidedly

injured by the excessive use of alcohol. Some of them practised allied vices (opium and chloroform). If the thirteen be included, the percentage rises to about twenty-three. The great majority of the thirteen are now deceased, and their deaths were certainly hastened by the same causes.

In the *University Calendar* for 1883-84 there are eighty-six Bachelors of Medicine on the list, of whom ten, or about twelve per cent., certainly used alcohol in excess, and were much injured thereby in every respect. Some of these ten are included in the thirteen above mentioned, but several of the thirteen had died in the interval.

In the *University Calendar* for 1885-86 there are 106 Bachelors of Medicine on the list, of whom twelve, or about eleven per cent. became distinct alcoholics.

In all these cases the habits of intemperance began, I believe, subsequent to their entry into student life, in most cases they were not pronounced until leaving it. Whatever may be the value of these figures the real truth is, if anything, understated. The diminution in the percentage in the more recent years may, or may not be fallacious; it may be due possibly to increasing civilisation in the colony, or it may be due on the other hand to the shortness of the interval which has elapsed, and consequent anticipation of results. Further, I find it much more difficult to trace the movements of the more numerous graduates in recent years.

Again emphasising the fact that the conclusion may be understated, but is certainly not overstated, it can only be described as appalling. That such a number of men who have been reared, as Carlyle puts it, "at infinite trouble and expense," and who have qualified themselves by a course of long and severe study to practice a most interesting profession, should then pass into the world to obstruct, and not assist, social progress, to become not objects of respect, as cultivated and useful citizens, but a byword and reproach, can only excite the most profound dismay.

Be it observed that the figures in themselves warrant no conclusion whatever on the vexed question, whether alcohol is the cause or the consequence of destruction, or both. Whether, in other words, alcoholism is a symptom of moral deterioration, or whether moral deterioration is a symptom of alcoholism, or

whether they mutually interact. They further in no way indicate any specific remedy. The broad fact remains, that of the graduates in medicine of the Melbourne University, at or about the years named, about one in seven became social wrecks, the proximate cause of the disaster being, what the total abstainers designate, in the words of Robert Hall, "liquid fire and distilled damnation."

Art. X.—*An Operculum from the Lilydale Limestone.*

(With Plate IX).

By R. Etheridge, Junr., Corr. Member.

[Read 14th September, 1893].

The opercula of Univalves are amongst the less common fossils met with in rocks of Upper Silurian age, but although known to occur in those of Europe, have not been described, so far as I am aware, from deposits of a similar nature in Australia. My acquaintance with opercula from the Lilydale Limestone was first made through the collection of Mr. G. Sweet, of Brunswick, and subsequently by means of collections made at Lilydale by Mr. A. J. North, on behalf of the Australian Museum, Sydney. These bodies were also casually referred to by Messrs. G. B. Pritchard and T. S. Hall* during the discussion on the Rev. A. Cresswell's paper† "Notes on the Lilydale Limestone." The observations in question will be referred to later.

The Opercula are disc-shaped, amphicœlous, strongly reminding one of the vertebral centrums of some fish. Those I have seen vary in size from half to once inch in diameter, and are bevelled from the exterior inwards along the sides. Further, they are thick solid bodies, almost equally concave, but the concavity less acute on the exterior, and more gradually inclined inwards than on the interior. The periphery of the latter side is flattened, the central area small, depressed, and circular, and often presenting a minute central nucleus. The thickness on the sides of the largest example I have seen is two-eights of an inch, or a trifle over; the thinnest, three-sixteenths of an inch. Mr. Pritchard informs me that he possesses examples of these opercula varying in size from one-sixteenth to one and a quarter inches in diameter, and from one-fiftieth to one-quarter of an inch in thickness. The structure is very apparent, even to the naked eye, the exterior exhibiting close concentric thread-

* Proc. R. Soc. Vict., 1893, v. (n.s.), p. 260. † *Ibid*, p. 38.

like lines, the edges of the component laminæ. Every here and there one is larger than the others. In sections prepared for the microscope, the concentric laminæ become very apparent, both in horizontal and vertical sections. The latter also display the outline exceedingly well. The opercula are practically round, a fact which can be easily ascertained by following the concentric laminæ in a transverse section. This point is an important one, as it may bear on the question of the identity of the operculum to its shell.

Mr. T. S. Hall mentioned in the discussion before referred to, that an operculum had been found "wedged into the mouth of an Euomphalus." Not having seen this genus amongst the Lilydale fossils, I am unable to follow the suggestion further, but must fall back upon the question—Do these opercula appertain to either of the described shells, *Oriostoma Northi*, or one of the *Cyclonemæ?* The mouth in the former is not, strictly speaking, round, but angulated towards the inner lip. On the other hand, *Cyclonema australis*, and probably also *C. lilydalensis* possess a round mouth, but this difficulty presents itself—the smallest operculum before me is too large for the largest *C. australis.* It is hardly necessary to consider such a form as *Phanerotrema australis*, that being a member of the Pleurotomariidæ, in which the operculum is corneous; but, at the same time, so far as mere size goes, the mouth of this species would far better accommodate a body of the size of these opercula than the shells mentioned above. If one may be permitted to surmise that the *Euomphalus* mentioned by Mr. Hall be *Oriostoma Northi*, then the matter narrows itself down to the question, is the operculum in such a position that it can be regarded as *in situ?* If on the other hand the shell be *Euomphalus* the matter becomes still more interesting. Let us now consider what previous investigations on Silurian opercula teach us.

Many years ago Dr. F. Smithe, M.A., figured* the well-known Wenlock shell, *Oriostoma sculptum*, Sby. sp., with its operculum *in situ.* The latter is plano-concave, plane without, concave within, formed of twelve concentric laminæ, and with a well-marked nucleus and bevelled edges; therefore, except in its

* Observations on the Opercula of some Silurian Gastropoda.—Proc. Cotswold Nat. Field Club.

section, remarkably like the opercula from Lilydale. In 1881 I figured* some of these bodies from the Carboniferous and Wenlock rocks of Great Britain, and the Wenlock of Gotland. Those from the English Wenlock occupy the mouths of *Oriostoma sculptum*, Sby., and are depressed-conical, circular bodies, bearing seventeen or more concentric rings. The other side is flattened near the margin and then rises at the centre into a low spiral eminence. Allowing for the state of preservation, and slight variability, these agree perfectly well with those figured by Mr. Smithe and also those now about to be referred to.

By far the most complete set of Silurian opercula figured, however, are those from the Wenlock rocks of Gotland, by Dr. G. Lindström.† He gives illustrations of those of *Oriostoma coronatum*, Linds., and *O. globosum*, Schl., besides a number of others not relegated at the time he wrote to their proper species. The whole of these are conical, in a greater or lesser degree, and are thus described:—"The operculum, *i.e.*, of the genus, is calcareous and solid, on the inner side smooth with a thick, elevated rim round the margins, outside conical, sometimes higher than broad, covered with a number of spiral coils, ornamented with exceedingly thin lines."‡ It will be at once apparent that the opercula from Lilydale differ from those of the Gotland molluscs in the entire absence of any conical outline; on the contrary, they are flattened disk-shaped. Lindström figures one of the less conical filling the aperture. The variation in form is very remarkable, from a depressed conical, through a depressed roundly-conical, to an elongately-conical, or absolutely plug-shaped outline, much resembling some rifle bullets. At the same time all possess the flat or very slightly concave inner face, accompanied by the external concentric coils, the latter having a more or less subimbricating appearance.

The operculum of *Cyclonema* is thus described:—"The operculum is broadly conical, with some ten large coils outside, impressed by a shallow groove along their superior border, and streaked by oblique, transversal lines."§ Illustrations‖ are given

* Ann. Mag. Nat. Hist., 1881, vii. (5), p. 29.

† The Silurian Gastropoda and Pteropoda of Gotland, 1884, t. 17.

‡ *Ibid.*, p. 156. § *Loc. cit.*, p. 174. ‖ *Ibid.*, t. 17.

of the operculum of *C. striatum*, His., and of those of two other undetermined species. The general type is quite similar to that of this portion of the shell economy in *Oriostoma* as figured by Lindström. The Lilydale opercula more closely resemble those described by Smithe and myself from the Wenlock beds, than they do those from Gotland; at the same time, trivial differences which strike the eye on close examination, may ultimately prove of wider significance. The cross section of an operculum given by Smithe is most undoubtedly more akin to that of the Lilydale specimens than are any sections which could be derived from the Gotland examples. The latter are wholly plano-conical in section, Smithe's Wenlock operculum is certainly plano-concave, whilst the Lilydale forms, on the other hand, are either bi-concave, or slightly plano-concave.

It is possible that the shell spoken of by Mr. T. S. Hall as *Euomphalus* may throw some light upon this subject, and I should much like to be permitted to examine this specimen.

A strange similitude to some of these opercula is seen in a fossil from the Corniferous Limestone of Indiana, described by Mr. S. A. Miller as a sponge, under the name of *Cyclospongia discus*.* It is "circular, button-shaped or discoid, and consisting of numerous thin, calcareous laminæ, having a concentric structure and filled with minute canals or interstices." The upper surface is slightly convex, bearing numerous concentric lines, the under side slightly concave, with a "broad, undefined, shallow furrow near the circumference, and round depression in the centre." Were it not for the minute canals I should be much tempted to regard this object as an operculum.

I am indebted to Mr. C. Hedley, F.L.S., for the accompanying drawings.

POSTSCRIPT.

Through the courtesy of the Honorary Secretary of the Royal Society I have been permitted to add some additional information obtained since this paper was written, and kindly contributed by Mr. G. B. Pritchard. The latter informs me that he has in his

* Seventeenth Report Geol. Survey Indiana, 1892, t.1., f. 8 and 9.

injured by the excessive use of alcohol. Some of them practised allied vices (opium and chloroform). If the thirteen be included, the percentage rises to about twenty-three. The great majority of the thirteen are now deceased, and their deaths were certainly hastened by the same causes.

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Art. XI.—*Additional Notes on the Lilydale Limestone.*

By Rev. A. W. Cresswell, M.A.

[Read 14th September, 1893.]

The only additional information in regard to the Stratigraphical Geology of Lilydale that I have to record is that about half a mile to the west of the strike of the Limestone of Cave Hill, and running conformably with it, *i.e.* a few degrees to the east of north, and to the west of south, and dipping from 30° to 45° east, is a series of mudstones, shales, and shaly sandstones yielding a profusion of fossils, mostly casts, but very well preserved, specimens of which are to be seen on the table.

Among the *Brachiopoda* are "Leptagonia deltoidea," "Leptœna sp.?," "Orthis subquadrata" and "elegantula," "Spirifer plicatellus," "Pentamerus Australis" and "Rhynchonella Stricklandi?" Among the *Lamellibranchiata* the most common form is "Pterinœa sub-falcata" or an allied species. Of the *Gasteropoda* "Bellerophon Cresswelli" (Etheridge) is a common form. And of *Cephalopoda*, "Orthoceras ibex," and "capillosus" are species that are both well represented. The *Trilobitidæ* are represented by "Homalonotus Harrisoni," tails of which are very common, and *Crinoid* stems of the Actinocrinus type are also very abundant.

The fossils are easily obtained by splitting the shales along the planes of stratification, and the places which I have visited and from which I have procured specimens are:—

(1) A point on the Mooroolbark Road close to the gate of entrance to Mr. Kinsella's farm, where the shale or mudstone is exposed under the overlying basalt in a cutting.

(2) On the old Melbourne Road, near the top of the hill, about half a mile above Lilydale, in the stuff thrown out of a sinking for a tank at Mr. Wilson's.

(3) About three miles to the north of the last mentioned point, and about fifteen chains to the west of the road that leads past the cemetery (N. and S. road) at an old quarry, known as Hughes' quarry.

In regard to the Cave Hill Limestone itself or rather it contained fossils, before giving any additional notes on this head, I have first to retract a statement I made in the paper read here in July of last year as to the occurrence of a gasteropod shell belonging to the genus "Stomatia," and which I called *S. antiqua*, supposing it to be the oldest Stomatia on record. This determination was an erroneous one, as it was founded upon what has since turned out to be a very imperfect specimen of a different shell, but which in its fragmentary form was so strikingly like a Stomatia that I was quite "taken in" by the appearance of it. However, I remarked at the time that the whorls were steeper in the sides and more flattened than Stomatias usually are. A somewhat better specimen has convinced me that the shell is not a Stomatia at all, but what it exactly is, it is difficult to say at present, for even this specimen is by no means perfect. It is possibly a very eccentric Trochus, eccentric of course in the literal sense of the word in having the axis or columella very remote from the centre, and besides this the whole shell is much depressed for a Trochus. However, I have learnt caution, and will endeavour to get a better specimen before committing myself to anything beyond the assertion that it is not a Stomatia.

Euomphalus (Oriostoma) Northi.

I have much pleasure in being able to exhibit on the table this evening a tolerably perfect specimen of Euomphalus Northi (or according to Mr. Etheridge, Oriostoma Northi) with the operculum that has been the subject of so much controversy *in situ*. The controversy as to the operculum has been first as to the nature of it, some taking it for a nummulite, and some for the lid of a coral, others for the vertebra of a fish; but I think there was a general consensus of opinion amongst our Victorian geologists from the first that it was the operculum of a gasteropod shell, the only difference amongst us being as to what species of shell it belonged to; some thinking it was the operculum of Cyclonema others that it belonged to Euomphalus (or Oriostoma) Northi.

The discovery of the specimen exhibited to-night must for ever set at rest any further dispute both as to the nature of it and as to the species to which it belongs. It is a veritable operculum, and

as certainly belongs to Euomphalus (or Oriostoma) Northi, for there it is *in situ*, and a grain of fact is worth a pound of theory.

And now a word or two as to the bearing of this discovery on the question as to the true genus to which the shell itself belongs. Although, in deference to Mr. Etheridge, I have quoted it by the generic name he has given it, viz., Oriostoma as an alternative to our name Euomphalus, Victorian geologists had always recognised it as a Euomphalus, and it appears to me that the form of the operculum it is now found to have possessed confirms our view, for, as Mr. Etheridge himself admits, Oriostomas have conical opercula, whereas this operculum is plano-concave and multispiral, or rather many times concentric, more like that of Euomphalus. As a further point of resemblance to Euomphalus, it is well-known that in Euomphalus the apex of the whorls is often filled up by a secondary deposit of shell and the interior is often divided off by transverse shelly partitions. Well, the same feature is also to be seen in our genus when ground down, as exhibited in the large specimen on the table; as however this is a feature not confined to Euomphalus alone, but often found in other shells of lengthened spire as well, it can only be regarded as a slight confirmation. It would be presumption on my part to differ from so high an authority as that of Mr. Etheridge in a matter of Palæontology, were I not fortified by the result of an appeal to another high authority, for I have shown this specimen to Professor Sir F. McCoy, and he tells me it is not the first he has seen from Lilydale with the operculum *in situ*, for Mr. Pritchard showed him an imperfect specimen of the same kind some years ago, and he authorizes me to state that he regards the shell as certainly an "Euomphalus," and not an "Oriostoma" at all, the latter being a name he restricts to a Tertiary genus.

Niso (Vetotuba) Brazieri.

There is a species of Gasteropod shell which Mr. R. Etheridge has described in the records of the Australian Museum, Sydney, vol. i., No. 3, as occurring in the Cave Hill Limestone at Lilydale, and to which he has given the name of Niso (Vetotuba) Brazieri. He says the material for giving a description of the shell is very imperfect, but he has provisionally called it a Niso, on account

of its resemblance to that genus in several particulars, and especially in its having an umbilical cavity extending the whole length of the shell, but as Niso is not elsewhere known to occur as far back as the Upper Silurian, he suspects that further examination may show it to differ from Niso, and in that case he proposes to call it Vetotuba. I may mention that I have found several more perfect specimens than the one he figures, demonstrating that which he surmises as possible, a very marked difference to Niso in that the umbilical cavity appears to project below the base of the shell in the form of a short tube, somewhat like the anterior canal of a Cerithium, only straight instead of abruptly turned to one side, and being an extension of the hollow columella, and not a mere prolongation of the mouth. Under these circumstances I prefer to adopt Mr. Etheridge's alternative name Vetotuba. There are at least two species if not more of these turreted shells belonging to the Pyramidellidæ. The above remarks apply more especially to the one he figures under name Niso (Vetotuba) Brazieri, and which, as he says, has no more than twelve whorls. I have however in my possession and on view to-night, another species much more slowly tapering and consisting of nearly twenty whorls, but the anterior part is not sufficiently perfect to define it, and so we must wait for a better specimen. Besides this I may mention that there is a small species that has more resemblance to a true Niso.

ART. XII.—*Note from the Biological Laboratory of the Melbourne University :—On a Crayfish with abnormally developed Appendages.*

By ARTHUR DENDY, D.Sc.

[Read 14th July, 1893.]

In the five posterior thoracic limbs, or ambulatory appendages, of the common fresh-water Crayfish, the exopodite has, as a rule, completely disappeared, and the limb is formed of protopodite together with very strongly developed endopodite.

Professor Huxley, in his well-known works on the Crayfish,* referring more particularly to the European *Astacus*, observes, "I have not been able to discover, at any period of development, an outer division or exopodite in any of the five posterior thoracic limbs. And this is a very remarkable circumstance, inasmuch as such an exopodite exists in the closely allied lobster in the larval state; and, in many of the shrimp and prawn-like allies of the Crayfish, a complete or rudimentary exopodite is found in those limbs, even in the adult condition."

The common Australian Crayfish (*Astacopsis bicarinatus*) agrees very closely with the European form as regards the thoracic appendages. A few weeks ago, however, when we were dissecting this Crayfish, obtained in quantities from the University pond, one of the students called my attention to a peculiarity in the specimen with which he had been provided.

On examining this specimen I found that small exopodites were present on three of the ambulatory appendages, *viz.*, on the great chela and the succeeding appendage on the right side, and on the great chela alone on the left side. In size, shape, and position these abnormally developed exopodites closely resemble the normal exopodites of the third maxillipede. The specimen is a female, of moderate size.

The presence of these abnormal exopodites, which, so far as I am aware, have not hitherto been observed in any true Crayfish,

* International Scientific Series.

affords additional proof of the generally accepted view as to the derivation of the ambulatory appendages from the primitive biramose type. Their occurrence in an isolated specimen out of the many hundreds which have been examined by various workers is, doubtless, to be explained as an instance of reversion to an ancestral condition. An analogous case is afforded by the "antenniform ophthalmite" of *Palinurus penicillatus* described by Professor Milne-Edwards, and subsequently figured by Professor Howes in the Proceedings of the Zoological Society of London (17th May, 1887).

My thanks are due to Mr. A. W. Morton for calling my attention to the specimen described above, which is preserved in the Museum of the Biological School.

ART. XIII.—*Results of Observations with the Kater's Invariable Pendulums, made at the Melbourne Observatory.—June to September, 1893.*

By PIETRO BARACCHI, F.R.A.S.

[Read 13th October, 1893.]

The observations which form the subject of this paper were made with the three Invariable Pendulums of Kater's pattern marked 4, (1821) or 6, and 11, belonging to the Royal Society of London, and fully described in vol. v. of the account of *Operations of the Great Trigonometrical Survey of India*, and more recently by General Walker in the *Philosophical Transactions of the Royal Society*, vol. A., 1890, page 539. They were lent to Mr. Ellery for the purpose of being employed in the Gravity Survey of Australia proposed by the Royal Society of Victoria, and to be carried out by a committee specially appointed. These pendulums have been in existence over seventy years, and were swung in many parts of the world, at elevations ranging from sea-level to over 15,000 feet. As stated by General Walker, they were variously employed by Sabine, Bayley, Airy, and McClear, between the years 1822 and 1854. Captain Basevi took two of them, viz., No. 4 and No. 6 to India in 1864, where they were employed for eight years in gravity determinations, chiefly at stations along the Central Meridian Arc. of the Great Trig. Survey.

In 1881 and 1882 Colonel Herschel swung them at Greenwich and Kew, together with Pendulum 11, and afterwards took the three to America, swinging them at Washington and Hoboken. After completing his operations they were given over to Mr. Edwin Smith of the U.S. Coast Survey, by whom they were taken round the world, and swung at Auckland, Sydney, Singapore, Tokio, San Francisco, and again at the starting point, Washington. Lastly, in 1888 and 1889, the Revisionary Operations with the three pendulums at Kew and Greenwich

were undertaken, in consequence of discordance in the results of 1882.

They arrived in Melbourne in November, 1892, and Mr. Ellery made the necessary preparations for swinging them at the Observatory, and had all the various parts mounted and adjusted and ready for work by the middle of June last, when Mr. Love started the observations. At about the same time Lieut. Elblein of the Austrian warship *Saida*, swung three ½-second Pendulums of Colonel von Sterneck's type, at the Melbourne Observatory, thus connecting it with an independent basis, viz.: Vienna, where the absolute value of the Force of Gravity was determined by Professor Oppolzer. This increased the importance of the Melbourne swings with the Kater's Pendulums, for their results could be tested by two different series. It was decided in consequence, to extend the operations further than it was originally intended, taking for standard the revisionary work at Greenwich and Kew, and thus establish a satisfactory basis to which other Gravity determinations in Australia, made with Kater's or any different form of pendulums, might be referred. The Melbourne Observatory possessed all the necessary conditions for carrying out the observations under the best advantages.

The value of Gravity determinations by the differential method depends on the invariability of the pendulums used. There is evidence to show that when carefully handled, these pendulums remain unchanged and may be swung without re-grinding the knife edges for many years, and as the three Pendulums now employed have not been intentionally altered, or known to have met with any accident since Colonel Herschel swung them at Kew and Greenwich in 1882, it may be expected that they are now in the same condition as they were eleven years ago. Fortunately we have the means of testing this condition by swinging them again at Sydney, which it is to be hoped will be done, at the earliest opportunity.

The pendulums were swung in the eastern underground room in the main building of the Melbourne Observatory, which, having a stone pavement, offered all the required stability, and had also the advantage of keeping a fairly constant temperature. The clock by Shelton, the same as that used in England and India, was fixed to the south wall of the room, and the Pendulum Stand

and Observing Telescope were in a line with it, in the direction of the meridian. An image of the white disc attached to the pendulum of the clock was formed at the tail piece of the Invariable Pendulum, by the proper collimating lens, and was brought into the field of view of the Observing Telescope by a plain mirror, fixed at the object end, which could rotate in a plane at right angles to the meridian, thus enabling the observer to bring the eye end at any convenient altitude. The distances of the several parts from the tail piece were as follows:—Observing Telescope, o.g. 70·3 inches; disc on Shelton pendulum, 48 inches; collimating lens, 12·2 inches; arc scale, about 1 inch for No. 11, and 0·5 inches for No. 4 and No. 6. The arc scale was about 18 inches, and the plane of suspension about 68 inches above the floor of the room, which is 84 feet above sea-level.

The operations consisted in observations of coincidences, temperature, pressure and arc of vibration, and comparison of the Shelton clock, with the sidereal standard clock of the Observatory, the rates of which are always known from transit observations, and finally, the reduction of observations.

Observation of Coincidences.

The diaphragm in front of the disc carried by the pendulum of the Shelton clock was so adjusted as to have its inner edges tangential to the disc, when at rest. (The disc is of white card two inches in diameter and turned to a true circle in the lathe). The image of the disc formed at the tail piece by the collimating lens was made of the same width as the tail piece, and the arc of vibration at the commencement was made a little less than the arc of the clock. The Disappearance *D*, and the Reappearance *R*, of the apparent right edge of the disc (actually the eastern edge) was invariably observed. The times of the first four swings were observed by the Seth Thomas, a sidereal clock kept in the room for the purposes of the Observatory, which, being near and almost in front of the observer, could be seen better than the Shelton, and had the advantage of being directly compared with the transit clock on the tape chronograph; but this method introduced confusion, and was

abandoned. For all the remaining swings, the times of D and R were observed by the Shelton; the D taking place between an even and odd second, and R between an odd and even second. If the size of the segment of the disc, when last seen before D, was larger than the segment when first seen after R, one second was added to the even second of time immediately preceding D, and if the opposite occurred, one second was subtracted from the odd second of time immediately following R. This refinement was not necessary; but as the method required only a very little more attention it was followed throughout.

Temperature.

The temperature of the pendulum was frequently observed during each swing, and was shown by the two thermometers Fahr. Nos. 667 and 668, placed on the dummy pendulum inside the cylinder. The adopted correction to the mean reading of the two, was $-0^{\circ}.13$.

During the first few swings the gas was allowed to burn in the room; but this brought about irregular changes of temperature, and caused the upper thermometer to read higher than the lower, often by as much as 0·4 degrees. The gaslight was accordingly discarded. For the rest of the time, till the conclusion of the observations, the temperature in the room did not vary by as much as one degree Fahr., and the two thermometers read always nearly alike.

Two Richard's thermographs, No. 1577 and No. 3131, were placed close to the cylinder, giving a continuous record of the temperature. During the first twelve swings the changes were so irregular and large, amounting sometimes to 3° or 4° Fahr., that curves had to be formed and intergrated in order to obtain a satisfactory mean; but for the remaining swings, the mean of the observed temperatures at commencement and at the end of the swing, as shown by the two thermometers on the dummy with the correction $-0·13$ applied, was adopted as representing with sufficient accuracy the mean temperature of the pendulum.

Pressure of Air.

The pendulums were swung at the ordinary atmospheric pressure, which was shown by the barometer Neuman, No. 122, having a correction of—0·022. The extreme range from June to the middle of September was from 29·4 to 30·4 inches. Pressure and temperature readings were always taken, at intervals of about one hour generally; sometimes more frequently.

Arc of Vibration.

This was read on the arc scale in inches. In the earlier part of the operations, the arc was read frequently, and several intermediate coincidences were observed during a swing; but later, the arc was read only twice at commencement, being generally about 0·65 inches, and twice at the end of the swing, being then reduced to about 0·08 inches.

Levelling.

The planes of suspension were carefully levelled before the pendulum was suspended, and again when the pendulum was taken out of the cylinder. No other intermediate observations of level were made; but the scale at right angles to the arc scale was read for each swing. It was found that for pendulum No. 4 and No. 6 the reading of this scale was about 0·5, and remained fairly constant in both positions of the marked face; but the readings for pendulum No. 11, were about 0·9, for face "P" and 1·2 inches for face "M". According to the level, the planes of the three pendulums generally remained in good adjustment, during each respective series of swings. Mr. Ellery invariably placed the pendulums in and out, and changed the position of the marked face when required.

The Swings.

Each pendulum was swung an equal number of times with its marked face towards the observer, and towards the clock, the first position being designated by face "M," and the second by face "P." Twelve sets were observed for each pendulum; six in each position. The results for Pendulum No. 11 came out more

discordantly than those of the other two pendulums. It was feared that the ends of the knife edge sometimes touched one or other of the guiding faces close to the grooves which receive the knife edge when the pendulum is lifted off the planes. These pieces were taken off by Mr. Ellery on 6th September, and another series of twelve swings, six in each position, were observed under the new condition. This makes in all sixty swings of an average duration of five hours each. The general practice was to commence a swing at about 9.30 a.m., conclude it at about 3 p.m., commence another at 4 p.m., concluding at 9.30 p.m. Generally five coincidences were observed at the beginning and end of each swing. The pendulum was always started about half-an-hour before the first coincidence was observed.

Clock Rates.

Until the 12th August the Shelton Clock was compared with the Seth Thomas by eye and ear, the fraction of the second being determined by coincidences of beat, with a Mean Time Chronometer. The rates of the Seth Thomas were derived by chronographic comparison with the Standard Transit Clock, the error of which was determined by transit observations. After the 12th August, Mr. Ellery mounted an electric contact spring on the Shelton Clock, by which a signal was made at every sixtieth second, on the Tape Chronograph, on which the beats of the Transit Clock were simultaneously recorded, thus enabling a comparison of the two clocks to be made with all the accuracy obtainable. The uncertainty introduced by one of the weakest points in pendulum observations was, by this method of comparison, greatly reduced. A comparison was made at the commencement and end of each swing; but when two sets of swings were observed on the same day in succession, extending from 9 a.m. to 10 p.m., the rate of the Shelton Clock was derived from the two extreme comparisons in the morning and evening only, neglecting the two intermediate ones. In this way it was thought, although the rates for the two swings might be different, the resulting mean of the two vibration numbers would be improved. The Shelton Clock gave a good account of itself.

From 23rd June to 18th July it had a losing rate, gradually increasing from $1^{s}\cdot 9$ to $3^{s}\cdot 0$. It was then stopped to form the connection above mentioned, when the pendulum was slightly shortened. From 14th August to 14th September its meam gaining rate was $2^{s}\cdot 5$ per day, the greatest variation from mean being about $0^{s}\cdot 5$.

Reduction of the Observations.

The instructions contained in General Walker's *Memoranda on Pendulum Observations for the Melbourne Observatory* were followed throughout, excepting some slight variation in form, and in the co-efficient in the formulæ for the arc correction. The notation and formulæ used are as follows, viz:—If n is the number of observable coincidences during an interval I, and N the interval between two consecutive coincidences, then $I=(n-1)\cdot N$

I is obtained by subtracting the first three, four, or five from the last corresponding three, four, or five observed coincidences and taking the mean of the differences. N being approximately known from observations of two consecutive coincidences n is at once derived, with which the mean value of N is computed.

R = number of sidereal seconds in a mean solar day plus the daily rate of the clock Shelton.

V_1 = uncorrected number of vibrations made by the free pendulum in a mean solar day, then $V_1 = R - \frac{2R}{N}$

The vibration numbers V_1 resulting from each swing, were all firstly reduced to the mean temperature 62° Fahr., to 26 inches pressure at 32° Fahr., and to infinitely small arc, by the following formulæ, viz.:—

$$\text{Pressure correction} = 0{\cdot}34.\frac{B-26}{1+0{\cdot}0023\,(T-32)} = \beta$$

$$\text{Arc correction} = V.\left(\frac{D-d}{16rD}\right)^2.\left\{(a+b)^2 - \tfrac{1}{3}(a-b)^2\right\} = a$$

$$\text{Temperature correction} = 0{\cdot}45(T-62^{\circ}) = \tau$$

In which,

B = Observed reading of Barometer − 0·022 and reduced to 32° Fahr.

T = Mean Temperature of the Pendulum during the swing.

a and b.—The observed Arc of Vibration in inches at the commencement, and at the end.

D, d, and r.—The distances of the Arc Scale from the observing telescope, tail piece and knife edge respectively. It was adopted for the three pendulums. $V.\left(\frac{D-d}{16r.D}\right)^2 = 0{\cdot}13$

Hence,

$$\text{Arc correction} = 0{\cdot}13\left((a+b)^2 - \tfrac{1}{3}(a-b)^2\right)$$

And if V = number of vibrations in a mean solar day reduced to 62° Fahr., 26 inches pressure and infinitely small arc, we have $V = R - \frac{2R}{N} + \alpha + \beta + \tau$. This is the formula used in the reductions.

The general results are given in the following tables: Note—A full account of these operations will appear in the publications of the Melbourne Observatory.

MELBOURNE OBSERVATORY.—Collected results of Pendulum Swings (June—September, 1893). Being the number of Vibrations made by each Pendulum in a Mean Solar Day. Reduced to Mean Temperature 62° Fahr., 26 inches Pressure at 32° Fahr., and infinitely small arc. Height above sea-level, 86·5 feet.

TABLE I.

PENDULUM No. 4

FACE M.			FACE P.			
No. of Swing.	Date.	No. of Vibrations.	No. of Swing.	Date.	No. of Vibrations.	
9	July - - 15	86099·39	11	July - - 17	86099·24	Face M ... 86099·45
10	,, - - 17	86099·41	12	,, - - 18	86099·22	Face P ... 86099·09
15	August - 16	86099·55	13	August - 14	86099·07	Mean ... 86099·27
16	,, - 17	86099·44	14	,, - 15	86099·26	
17	,, - 17	86099·47	20	,, - 19	86098·96	
18	,, - 18	86099·31	21	,, - 20	86099·04	
19	,, - 18	86099·48	22	,, - 21	86098·92	
24	,, - 22	86099·54	23	,, - 21	86099·05	

PENDULUM No. 6.

FACE M.			FACE P.			
No. of Swing.	Date.	No. of Vibrations.	No. of Swing.	Date.	No. of Vibrations.	
5	July - - 7	85999·25	7	July - - 9	85999·35	Face M ... 85999·43
6	,, - - 8	85999·63	8	,, - - 10	85999·27	Face P ... 85999·43
25	August - 25	85999·45	31	August - 28	85999·38	Mean ... 85999·43
26	,, - 26	85999·31	32	,, - 29	85999·25	
27	,, - 26	85999·45	33	,, - 29	85999·30	
28	,, - 27	85999·59	34	,, - 30	85999·68	
29	,, - 27	85999·48	35	,, - 30	85999·70	
30	,, - 28	85999·29	36	,, - 31	85999·46	

PENDULUM No. 11.

FACE * M.			FACE P.			
No. of Swing.	Date.	No. of Vibrations.	No. of Swing.	Date.	No. of Vibrations.	
3	June - - 25	86050·98	1	June - - 23	86050·10	
4	„ - - 26	86050·36	2	„ - - 24	86050·56	
37	August - 31	86051·40	43	September 3	86050·07	
38	September 1	86051·30*	44	„ 4	86050·30	Face M .. 86051·08
39	„ 1	86051·49	45	„ 4	86050·73	Face P ... 86051·04
40	„ 2	86050·93	46	„ 5	86050·99	
41	„ 2	86051·08	47	„ 5	86051·10	Mean ... 86051·06
42	„ 3	86051·10	48	„ 6	86051·07	
55	September 10	86051·13	49	September 6	86051·55	
56	„ 11	86051·08	50	„ 7	86051·74	
57	„ 11	86051·22	51	„ 7	86051·62	
58	„ 12	86050·97	52	„ 8	86051·48	
59	„ 12	86050·97	53	„ 9	86051·55	
60	„ 13	86051·08	54	„ 10	86051·74	

In order to make the vibration numbers just given comparable with the Greenwich and Kew results, they must be reduced to vacuum and sea-level. For the reduction to vacuum, using the same formula as before, we have:

$$\text{Correction} = 0\cdot34.\frac{26}{1+0\cdot0023\times30} = 8\cdot269$$

and treating the correction for height of station, in the same way, as General Walker did for Kew and Greenwich (see *Phil. Trans.*, v. 1890, A., page 557), viz.—Correction $= \frac{h}{243}$ in which the height h may be put as 86·5 feet, we have

$$\text{Correction to sea-level} = \frac{86\cdot5}{243} = 0\cdot355$$

$$\text{Total correction} = +8\cdot62$$

The following table shows the concluded vibration number for each pendulum at the Melbourne Observatory.

TABLE II.

No. of Pendulum.	Number of Vibrations in a Mean Solar Day, reduced to the Mean Temperature 62° Fahr., infinitely small Arc, and		
	To Pressure of Air 26 inches at 32° Fahr.	To a Vacuum.	To a Vacuum and Sea-level.
4	86099·27	86107·54	86107·89
6	85999·43	86007·70	86008·05
11	86051·06	86059·33	86059·68

COMPARISON OF THE VIBRATION NUMBERS OF THE THREE INVARIABLE PENDULUMS AT GREENWICH, KEW, SYDNEY AND MELBOURNE.

As no swings under low pressure have been observed at Melbourne, only the results of swings under high pressure observed at Greenwich and Kew are taken into account in this comparison.

The following numbers are taken from General Walker's paper in the *Phil. Trans.*, vol. 1890 A., page 551, 553 and 558.

TABLE III.

Number of Pendulum.	Number of Vibrations in a Mean Solar Day reduced to Mean Temperature 62° Fahr., infinitely small Arc and to a Vacuum.		Number of Vibrations in a Mean Solar Day reduced to Mean Temperature 62° Fahr., infinitely small Arc and to the Density of Air under the Pressure of 26 inches at 32° Fahr.
	Greenwich Results, 1889, by Mr. Hollis.	Kew Results, 1888, by Mr. Constable.	Sydney Results, 1883, by Mr. Edwin Smith.
4	86164·04	86165·27	86090·93
6	86063·94	86065·80	85990·32
11	86115·68	86116·04	86042·08

General Walker states in his paper above cited that the Greenwich and Kew swings were reduced to a vacuum by using the Kew formula,

$$\text{Correction} = 0{\cdot}32\frac{\beta}{1+{\cdot}0023(\tau-32)}$$

Hence in order to make them comparable with the Melbourne swings, they must be increased by the quantity

$$\left(0{\cdot}34-0{\cdot}32\right).\frac{27}{1+{\cdot}0023\times 30}=+0{\cdot}505.$$

They must also be reduced to sea-level by applying the corrections $\frac{157}{243}=+0{\cdot}646$ for Greenwich and $\frac{15}{243}=+0{\cdot}061$ for Kew.

For Sydney the reduction to sea-level is $\frac{140}{243}=+0{\cdot}576$

$$\text{Reduction to a vacuum } 0.34.\frac{26}{1+0{\cdot}0023\times 30}=+8{\cdot}269$$

The whole correction to be applied to the numbers in Table III. is therefore :

To Greenwich numbers		+ 1·15
„ Kew	„	+ 0·57
„ Sydney	„	+ 8.85

Table IV.

Number of Pendulum.	Number of Vibrations made in a Mean Solar Day, reduced to a Vacuum, to Temperature 62° Fahr., to infinitely small Arc and to Sea-level.				Differences.				
	Greenwich.	Kew.	Sydney.	Melbourne.	G-M.	K-M.	M-S.	K-G.	K-S.
4	86165·19	86165·84	86099·78	86107·89	+57·30	+57·95	+8·11	+0·65	+66·06
6	86065·09	86066·37	85999·17	86008·05	+57·04	+58·32	+8·88	+1·28	+67·20
11	86116·83	86116·61	86050·93	86059·68	+57·15	+56·93	+8·75	−0·22	+65·68
	Mean Differences - - - -				+57·16	+57·73	+8·58	+0·57	+66·31

This table (No. IV.) embodies the conclusion of the differential results. It will be seen that by diminishing the vibration number of Pendulum No. 6, and by increasing the vibration number of Pendulum No. 11 by (say) 0·5 vibrations in the column for Kew, the columns containing the differences would be brought into much closer adjustment. If comparisons of several clocks are involved in the operations, errors of 0·5 vibrations could be very easily introduced.

For the conversion of the differential results into absolute measure of the force of Gravity for Melbourne, we have now the Greenwich, Kew, and Vienna bases, and Professor Neumayer's independent value of g.

The absolute length of the seconds pendulum at Greenwich, was determined by General Sabine in 1830, by the convertible pendulum originally designed and employed by Captain Kater in 1817, and found to be 39·13734 inches. (See *Phil. Trans.*, 1831, Art. xxv).

In 1873 Major Heaviside determined the length of the pendulum vibrating seconds at Kew, using the same pendulum as that used by General Sabine at Greenwich; its length was remeasured by Colonel Clarke. As the result of these observations, the length of the seconds pendulum at Kew was determined to be 39·14008 inches, and this result was corroborated by the operations with the two reversible Russian pendulums at Kew, but these pendulums do not seem to have given satisfactory results elsewhere (as shown in the volume v. of *The Great Trigonometrical Survey of India).*

Professor Neumayer determined the value of g at Melbourne in 1863, by a reversible pendulum constructed by Mr. Lohmeir of Hamburg, under the supervision of Professor Peters of the Altona Observatory. Of these operations no detailed account seems to be available, and it would be desirable to know something more about them, so as to form a judgment as to the weight to be given to the result, before comparing it with the others.

Lieutenant Elblein gave to Mr. Ellery the following provisional results of his $\frac{1}{2}$ seconds invariable pendulum observations at Melbourne and Sydney:

Period of one vibration, reduced to 0° centigrade, to infinitely small arc, and to a vacuum, being the mean of three $\frac{1}{2}$ seconds pendulums

At Melbourne (86·5 feet above sea-level) $0^{s} \cdot 5066120$
At Sydney (140 feet above sea-level) $0^{s} \cdot 5063920$

and taking for the value of g at Vienna $g = 9 \cdot 80866$ meters as found by Professor Oppolzer by a reversible pendulum in the year 1886, he derived the following values, not reduced to sea-level.

Melbourne $g = 9 \cdot 80014$ meters
Sydney $g = 9 \cdot 79702$ meters

And reduced to sea-level,

Melbourne $g = 9 \cdot 80020$ meters
Sydney $g = 9 \cdot 79713$ meters

According to these values, the Indian pendulums should make 13·48 vibrations less at Sydney than the number of vibrations they make at Melbourne in a mean solar day. Therefore the difference 8·58 given in Table IV. is too small by nearly 5 vibrations, according to Lieutenant Elblein's provisional results.

This fact casts a doubt either on some of the observations or on the invariability of the pendulums, as the discordance is quite independent of the absolute values chosen as bases, and small differences in the formulæ used for computing the various corrections could not account for such a large error. It is therefore all the more urgent to swing the Pendulums at Sydney at the very first opportunity.

The several values of g for Melbourne derived from the above sources are as follows, viz.:—

By the Greenwich and Melbourne swings, and the length of the seconds pendulum as 39·13734 inches at the former place	$g = 32 \cdot 14645$ feet $g = 9 \cdot 79815$ meters
By the Kew and Melbourne swings, and the length of the seconds pendulum as 39·14008 at the former place	$g = 32 \cdot 14827$ feet $g = 9 \cdot 79870$ meters
Provisional value of Lieutenant Elblein	$g = 32 \cdot 15317$ feet $= 9 \cdot 80020$ meters

Professor Neumayer's absolute determination $\left.\begin{matrix} \\ \end{matrix}\right\}$ $g = 32{\cdot}15127$ feet
$= 9{\cdot}799607$ meters

There is no urgent need for adopting at once a final value for g—at least not until the pendulums are swung again in England on their return.

The mean of the 4 values is 32·14979 feet or 9·79916 meters, which may be provisionally adopted.

ART. XIV.—*Notes on some new or little-known Land Planarians from Tasmania and South Australia.*

(With Plate X.)

By ARTHUR DENDY, D.Sc.

[Read 16th November, 1893.]

I.—TASMANIAN LAND PLANARIANS.

Geoplana tasmaniana, Darwin, sp.

Planaria tasmaniana, Darwin, Annals and Magazine of Natural History, vol. xiv. (1844), p. 246.

I have recived a large number of specimens from various parts of Tasmania which I believe to be referable to Darwin's species. The following description is taken from a living specimen collected by Mr. L. J. Balfour on Mount Wellington, in March, 1892 :—Body in life a good deal flattened, especially on the ventral surface, but with no well-marked lateral surfaces, the sides being rounded ; tapering very gradually in front, somewhat less so behind. When crawling, about 43 mm. long and 2·5 mm. broad. Ground colour of dorsal surface pale brownish-yellow, with five stripes of umber-brown. The median stripe narrow, dark and well-defined. The inner paired stripe broad and dark, but rather ill-defined, separated by an interval of ground colour about as broad as itself from the median stripe. The outer paired stripe at the extreme margin of the dorsal surface, narrow, rather faint and ill-defined, separated from the inner paired stripe by a band of ground colour about equal to the latter in width. Ventral surface white, with no markings. Anterior tip dark-brown. Eyes arranged as usual and continued all round the horse-shoe-shaped anterior extremity ; also continued down the sides of the body, sparsely, to the posterior end. After preservation in spirit the dorsal surface became more flattened, and its margins turned in to form more or less distinct but narrow lateral surfaces, carrying the ill-defined outer paired stripes. The peripharyngeal aperture (in spirit) is somewhat behind the middle and the genital aperture nearer to it than to the posterior end.

The copulatory organ may (in spirit) be protruded from the genital aperture in the form of a bladder-like vesicle, covered with numerous very minute, granule-like papillæ.

A good deal of variation occurs in the intensity of the colouration, and the consequent distinctness or otherwise of the stripes. The median stripe appears always to be the darkest and best defined.

There is a dwarf variety from the north coast of Tasmania, of which I received about twenty specimens collected by Mr. G. W. Officer, in February, 1892, and which differs from the types only in its very much smaller size.

At first sight this species looks a little like the common Australian *G. quinquelineata*, but it differs markedly in the shape of the body in spirit, the ill-defined character of the paired stripes, and the great breadth of the inner ones.

Localities.—Parattah (Professor Spencer; very common); Mount Wellington (L. J. Balfour, Esq.); near Newtown Falls (A. Morton, Esq.); North Coast (G. W. Officer, Esq.; dwarf variety only).

Geoplana diemenensis, n. sp.

This is a large and remarkably handsome species. The following description is taken from two specimens received alive from Mr. L. J. Balfour, who collected them on Mount Wellington in March, 1892:—

Body at rest quite flat on the dorsal surface; broad; with narrow, inwardly sloping lateral surfaces. When crawling almost the same shape in section but not quite so much flattened; tapering very gradually in front and behind; unusually sharp-pointed behind. Length when crawling about 70 mm.; breath about 6 mm. Eyes as usual in *Geoplana*, continued all round the horse-shoe-shaped anterior margin. Ground colour of the dorsal surface sepia-brown, with indications of three darker longitudinal stripes, all ill-defined. (In specimens subsequently received in spirit from Mr. Morton these stripes are better marked; there is one narrow median stripe and a pair of much broader ones close to the margins of the dorsal surface). The dorsal surface is sprinkled all over, stripes and all, with small whitish specks; while under a low power of the microscope much smaller greenish specks,

probably groups of rod-cells, are also seen to be present. Anterior extremity dark sepia. Lateral surfaces mottled in about equal proportions of white and sepia. Ventral surface entirely white.

In spirit the peripharyngeal aperture is situated a little in front of the middle of the body and the genital aperture a little nearer to it than to the posterior end. The copulatory organs are extraordinarily large and complicated, and may (in spirit) be protruded from the genital aperture in the form of a pair of fleshy, somewhat comb-like processes, each bearing numerous conspicuous conical papillæ.

A slight variety of the species, obtained in quantity by Professor Spencer at Parattah, differs somewhat in markings from the typical form. An additional dark, ill-defined, paired stripe is present on each side of the median dorsal stripe, half way between it and the marginal stripe; and the speckled character of the dorsal surface is much less pronounced. Specimens of this variety (which I have seen only in spirit) approach *G. tasmaniana* in general appearance, but differ in the greater breadth of the body and, apparently, in the structure of the copulatory organs, which resembles that described in the type.

Professor Spencer also informs me that he found the species abundantly near Emu Bay, in January, 1892; that it sometimes attained a larger size than those described above, and that it varied considerably in colour. Unfortunately, the specimens collected by him in this locality all died.

It appears not unlikely that this species, in spite of its very much larger size, may be nearly related to our Victorian *G. quadrangulata.* So I judge from the characteristic shape of the body and the fundamental pattern. The point cannot, however, be determined without anatomical investigation, especially of the copulatory organs.

Localities.—Mount Wellington (L. J. Balfour, Esq.); near Newtown Falls (A. Morton, Esq.); North Coast (G. W. Officer, Esq.); Emu Bay (recorded by Professor Spencer); Parattah (Professor Spencer).

Geoplana lucasi, Dendy.

Geoplana lucasi, Dendy, Trans. Royal Soc. Vic., 1890, p. 74; 1891, p. 40, pl. iv., fig. 4.

With this rare Victorian species I identify, provisionally at any rate, three specimens received in spirit from Mr. Alexander Morton and Professor Spencer. They agree with the Victorian form in the characteristic broad, flattened body, much broader behind than in front; in the arrangement of the dark streaky markings on the dorsal surface; in the absence of markings on the ventral surface, and in the position of the external apertures (the peripharyngeal somewhat behind the middle of the body and the genital about half-way between it and the posterior end). The ground colour is yellow and the streaks or splotches dark-brown or purplish in spirit. In only one specimen, the smallest of the three, is the dark median dorsal line present, and even here not very strongly developed. The largest of the three specimens (in spirit) measures 27 mm. in length by 6·5 mm. in greatest breadth.

Localities.—Tasmania (A. Morton, Esq.); Lake St. Clair (Professor Spencer).

Geoplana mortoni, n. sp.

The following description is taken from five spirit specimens, which are so well preserved and well characterised that I have no hesitation in naming them, although I have not myself seen the animal alive. Four at any rate of the specimens reached me very soon after capture and have evidently undergone but little change in colour.*

Length (in spirit) about 40 mm., greatest breadth 5 mm. Broader, and much less gradually tapering, behind than in front. Dorsal surface strongly convex; ventral surface concave, with prominent, narrow margins. Dorsal surface yellow, closely mottled all over with small, irregular specks of brown. (The mottling, or marbling, is a good deal coarser in some specimens than in others). Ventral surface similar but paler, with the brown colour less developed and in smaller specks. A very narrow band of yellow, without any brown specks, occupies the prominent margins. The peripharyngeal aperture is situated in about the middle of the body, and the genital aperture usually

* Professor Spencer tells me that in life the colour is warmish yellow with warm umber splotches.

somewhat nearer to it than to the posterior end. The eyes, though not very numerous, are arranged as usual in *Geoplana.*

In the characteristic shape of the body this species closely resembles the Australian *G. fletcheri*, some of the varieties of which are also strongly speckled on the dorsal surface. It differs from *G. fletcheri* in the speckling of the ventral surface, the absence of continuous dark stripes, and the more anterior position of the apertures.

I have much pleasure in dedicating the species to Mr. Alexander Morton, of the Hobart Museum, from whom I first received it.

Localities.—Tasmania (Alexander Morton, Esq.); Parattah (Professor Spencer).

Geoplana munda, Fletcher and Hamilton.

Geoplana munda, Fletcher and Hamilton, Proc. Linn. Soc. N.S.W., ser. ii., vol. 2, p. 369, pl. v., fig. 8.

Geoplana munda, Dendy, Trans. Royal Soc. Vic., 1890, p. 73; 1891, p. 36.

Geoplana munda, Spencer, Proc. Royal Soc. Vic., 1890, p. 89, pl. xii., fig. 10.

In February, 1893, Professor Spencer collected a large number of this common Australian species at Parattah, thus extending its known range to Tasmania for the first time. The specimens, which he kindly handed to me in spirit, agree exactly with those commonly met with in Victoria.

Locality.—Parattah (Professor Spencer).

Geoplana adæ, Dendy, var. *fusca*, nov.

The following description is taken from a coloured sketch of the living animal (with measurements) drawn by Professor Spencer, and from three spirit specimens collected by him at the south end of Lake St. Clair, in January, 1893:—Body (when crawling) tapering gradually in front and behind; length 69 mm., greatest breadth 3 mm. The dorsal surface has a ground colour of purplish-grey, darkening in the middle line and at the margins, so as to form a narrow median, and a pair of mu broader

marginal stripes; none of the stripes well defined, however. The ventral surface is cream-coloured, with no markings, and is continued up round the sides of the body to form a border on either side of the dorsal surface, very sharply marked off from the dark-coloured portion. Hence, when the animal is viewed from the upper surface we see a broad median band of a dark colour bordered on either side by a narrow margin of pale cream colour, while in the dark band itself we can recognise three longitudinal stripes of darker colour than the rest.

In spirit the animal measures about 18 mm. in length, by 5 mm. in greatest breadth. The body is ovoid in section, somewhat flattened, especially on the ventral surface, but thick and with broadly rounded margins. Exactly the same colouration is visible as in the living specimen, except that the dorsal surface appears to be darker. The light margins are still conspicuous from the dorsal surface. The peripharyngeal aperture is slightly behind the middle and the genital aperture slightly nearer to it than to the posterior end. The eyes are very abundant, arranged as usual and continued down the light-coloured sides of the body to the posterior end.

This variety differs from the ordinary Victorian form chiefly in the absence of the narrow and sharply defined band of pale-yellow colour on each side of the dark median dorsal line. It appears to be a fairly well marked variety.

Locality.—Lake St. Clair (Professor Spencer).

Geoplana variegata, Fletcher and Hamilton.

Geoplana variegata, Fletcher and Hamilton, Proc. Linn. Soc., N.S.W., ser. ii., vol. 2, p. 364, pl. v., figs. 3, 3^1.

Geoplana variegata, Dendy, Proc. Royal Soc. Vic., 1891, p. 124, pl. ii., fig. 2.

A single specimen of this common New South Wales and Queensland species was obtained by Professor Spencer at Bedlam Heights, in January 1893, and, together with coloured drawings of the living animal, placed by him in my hands. I have no hesitation in making the identification, although, curiously enough, the species has not yet been found in the intervening colony of Victoria. The general shape of the body (in spirit),

the position of the external apertures, and, above all, the very characteristic arrangement of the coloured stripes, are identical. The general ground tint of the body in life was brown or bluish-brown, and the three narrow stripes, usually of "pale-yellow or greenish-yellow," lying in and near the mid-dorsal line, were decidedly green. When crawling, the specimen measured 44mm. long by 3 mm. broad.

Locality.—Bedlam Heights (Professor Spencer).

Geoplana typhlops, n. sp.

Geoplana alba, Dendy, Proc. A.A.A.S., Hobart, 1892, p. 370. (Not *G. alba* of previous papers).

In my previous notes on Tasmanian Land Planarians *(loc. cit.)* I identified two specimens of this species with the common Victorian *G. alba*, which it closely resembles in size, shape and colour. I noted, however, that I could find no eyes, and suggested that I might have overlooked them in the spirit-preserved specimens. I have, however, since then received several additional specimens, none of which show any eyes. One of these specimens I carefully examined in the living condition and could detect no eyes either under a hand-lens or when the head was compressed and examined under the microscope. The other specimens were examined in spirit. The Victorian specimens of *G. alba*, on the other hand, and also specimens of the same species which I have obtained from New Zealand, show the eyes distinctly under the dissecting microscope, even after being kept in spirits for many months. It therefore appears desirable to give a fresh specific name to the Tasmanian specimens, although I still believe them to be closely related to the common and widely distributed *G. alba*.

The following description of the species is based upon a very fine specimen which reached me alive and was collected by Mr. L. J. Balfour at Mount Wellington (Tasmania), in March, 1892:—When alive of a pale brownish-yellow colour on the dorsal surface; still paler on the ventral; anterior tip white. No stripes at all. When crawling, about 115 mm. in length and 4 mm. broad. In shape and size exactly like a large specimen of *G. alba*, with the same characteristic crenate edges when at rest and

slightly ridged dorsal surface. In spirit a distinct, translucent, median ventral band appears, as already noted in the original specimen (this is much more obvious in some specimens than in others). The peripharyngeal aperture (in spirit) is decidedly behind the middle of the body, and the genital aperture much nearer to it than to the posterior end. The pharynx is funnel-shaped. The eyes appear to be be entirely absent.

Diesing's *Geobia subterranea*, from Brazil, is described by Moseley* as "Long and narrow, with rounded extremities, eyeless, and colourless. Lives underground in the holes of *Lumbricus corethrurus*, and preys upon that annelid." I have Mr. Alexander Morton's authority for stating that *Geoplana typhlops* is also sometimes found underground, but I believe that this is true of many Land Planarians. Whether the genus *Geobia* can be maintained appears to me very doubtful.

Localities.—Mount Wellington (Mrs. Dendy and L. J. Balfour, Esq.); Hobart (A. Morton, Esq.); Parattah (Professor Spencer, six specimens).

II.—South Australian Land Planarians.

Geoplana quinquelineata, Fletcher and Hamilton.

Geoplana quinquelineata, Fletcher and Hamilton, Proc. Linn. Soc. N.S.W., ser. ii., vol. 2, p. 366, pl. v., figs. 4, 5, 15, 16.

The known range of this common New South Wales and Victorian species is now for the first time extended to South Australia by the researches of Mr. Thos. Steel, from whom I received two small specimens in spirit in May, 1892.

Locality.—Extreme summit of Mount Lofty (Thos. Steel, Esq., 3rd May, 1892).

Geoplana fletcheri, and var. *adelaidensis*, Dendy.

(Plate X.).

Geoplana fletcheri, Dendy, Trans. Royal Soc., Vic., 1890, p. 78, pl. vii., figs. 8, 9; 1891, p. 38, pl. iv., fig. 6. Proc. A.A.A.S., Hobart, 1892, p. 372.

* Quarterly Journal of Microscopical Science, vol. xvii. (N.S.), p. 289.

Geoplana fletcheri, var. *adelaidensis*, Dendy, Proc. A.A.A.S., Hobart, 1892, p. 373.

I am again indebted to Mr. Thos. Steel for no less than thirty-nine living specimens of this species, collected by him behind Mount Lofty on 3rd May, 1892. These specimens are extremely interesting, as exhibiting an unusual degree of variation in markings, as shown in the figures A to E (plate X.), and thereby connecting the typical *G. fletcheri* by almost insensible degrees with the, at first sight, very distinct variety which I have previously termed *adelaidensis*, and which I at first took to be a distinct species.

To judge from the large number of specimens met with in a very restricted area the species would appear to have its home in the Mount Lofty district, while in Victoria it is decidedly rare. It is interesting to note that no other species were found in association with it. The large number of specimens obtained by Mr. Steel is partly to be accounted for by the fact that the locality is a depôt for firewood brought from the immediately surrounding forest.

The general form of the specimens, including the strongly concave ventral surface, the markedly posterior position of the external apertures and the toughness of the skin, agree with the corresponding characters in the typical forms of *G. fletcheri* already described.

In all the specimens the ventral surface is of a pale yellow colour, without markings. The eyes are arranged in a not very densely crowded patch at each side of the head, in close-set single series round the horseshoe-shaped anterior extremity, and more or less sparingly all down the sides of the body to the hinder end.

Sometimes when at rest the body is supported on the edges of the ventral surface, leaving a hollow tunnel beneath the middle; this may be very conspicuous when the animal is resting on a sheet of glass and is viewed from beneath.

The variations in pattern, although very conspicuous, are all clearly due to the intensification or suppression of parts of what may be regarded as the typical pattern of the species; and, so far as I know, this statement holds good of all Land Planarians.

The ground colour of the dorsal surface varies from rich canary-yellow to very pale yellow. The markings (of various shades of

brown) on this ground colour vary from those of the variety *adelaidensis* (fig. A), through insensible gradations, to a form (D), which is almost entirely devoid of markings, but has just a faint rudiment of a median stripe, discontinuous, in the anterior half of the body, with still fainter rudiments of paired stripes at the extreme anterior end only, and faint traces of pale brownish specks at the posterior end visible under a pocket lens. This form (D) scarcely differs from the types of *G. fletcheri* first described from Victoria *(loc. cit.)*

The two other most conspicuous varieties are the ones labelled C and E in the drawings. In C there is a distinct but narrow, dark median stripe all down the body; the paired stripes, however, are present only at the extreme anterior tip, and there are only a few brown specks, very inconspicuous, in the ground colour at the posterior end.

In E, on the other hand, the median stripe is very thin and discontinuous, almost obsolete, while the paired stripes are strong and continuous all down the body, though evidently made up each of a number of specks run together, and stronger in front than behind. There are no distinct specks in the ground colour outside the stripes.

The variety represented in the drawing marked B is intermediate between A and C, all the markings of A (= var. *adelaidensis*) being present but, with the exception of the median stripe, fainter. In this variety *adelaidensis* (A and B) the dark-brown specks are sometimes very abundant at the outer margins of the body, indicating a tendency towards the formation of a second, outer paired stripe (compare *G. howitti**) especially marked at the anterior end.

Perhaps in all cases there are more or less distinct traces of five dark stripes, one median and four paired, running back from the dark pinkish-brown anterior tip. (Possibly *G. howitti* may ultimately have to be regarded merely as another variety of *G. fletcheri*, with its sub-variety *obsoleta*.)†

During the period for which I kept the above-described specimens of *G. fletcheri* and its varieties alive (3rd to 11th May),

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* Trans. Royal Soc. Victoria, 1891, p. 39, pl. iv., fig. 5.

† Proc. Royal Soc. Victoria, 1891, p. 37.

seven cocoons were laid by them. These varied somewhat in form, being nearly round, oval, or distinctly egg-shaped. The largest measured 4 by 3 mm., but two were much smaller. After being laid for a few days the cocoons had a dull, almost black colour. When freshly laid and while still within the body they had a rich chestnut-brown colour. Only one was observed inside the body, causing a swelling just behind the genital aperture.

About a month after the cocoons were laid the young began to hatch out. On 6th June I found two recently hatched young in the vivarium. They were only about 8 mm. long when crawling. Shape and movements of the body as in the adult. Eyes abundant in single series on the sides of the head, round the horseshoe-shaped anterior margin, and continued more sparingly to the posterior end. The ground colour of both surfaces was bright yellow, with distinct brownish-pink anterior tip. In both specimens specks of brown pigment were scattered over the dorsal surface. In one they were clearly arranged as in fig. E of the adult, with the addition of scattered specks outside the outer band of specks. The other specimen only showed traces of a similar arrangement.

On 9th June three more young were observed, one of which showed three distinct longitudinal lines of specks as before, while the other two showed only a very few, faint, scattered specks.

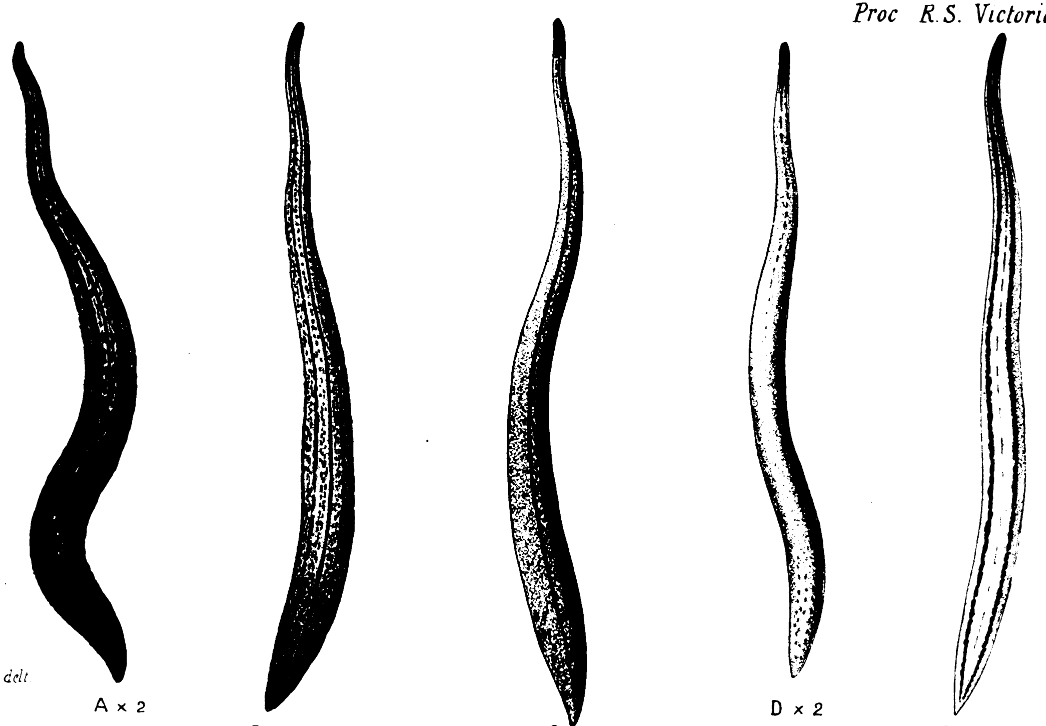
I have no observations as to the number of young developed in each cocoon, probably two or three, as in other species (*e.g.*, I have found three young in a cocoon of *G. alba*). After the escape of the young the split shell still contains a quantity of milky fluid and curls up.

Locality.—A deep gully just behind Mount Lofty (T. Steel, Esq.)

In conclusion, I desire to express my thanks to Professor Spencer and Messrs. Alexander Morton, G. W. Officer, L. J. Balfour and Thos. Steel for the specimens described in this paper.

DESCRIPTION OF PLATE X.

Five specimens of *Geoplana fletcheri*, selected from a collection of thirty-nine specimens and drawn from life to illustrate the variation in colour-markings. All the specimens are viewed from the dorsal surface, and represented of twice the natural size. (Fig. A represents the variety *adelaidensis*, which has the most strongly developed markings).



Arthur Dendy delt.

A × 2 B × 2 C × 2 D × 2 E × 2

VARIATION IN GEOPLANA FLETCHERI.

R. Wendel lith Melb.

segmentation, notwithstanding the adherent matrix; (2) the absence of any trace of a limb, or striated margin posteriorly or laterally; and (3) the presence of the apical emargination. There is, on the other hand, a definite thread-like margin round the sides and hinder portion, which at once dispels the idea that the plate might be a portion of some other organism; and I think that the lateral segmentation radiating outwards on both sides places its identity, so far as the generalised systematic position is concerned, beyond doubt, but a reference to some one of the known genera is a more difficult task. Perhaps the easiest method of arriving at a decision on this point will be by a process of elimination. The characters, so far as they can be deciphered, at once forbid the entrance of the fossil within the families of the Harpedidæ, Remopleuridæ, Olenidæ, Conocephalidæ, Calymenidæ, Æglinidæ, Cheiruridæ, Encrinuridæ, Didymenidæ, Acidaspidæ, Lichadidæ, Phacopidæ, Proetidæ, Trinuclidæ, and Agnostidæ, thus leaving the Asaphidæ, Bronteidæ, and Illænidæ to choose from.

In the Asaphidæ, *Asaphus* and *Ogygia* being the typical genera, the caudal shield is often of large size, and in some species of the former obscurely segmented, but in other *Asaphi* both the axis and pleural segments are well defined. In *Ogygia* the tail is wide transversely, with a wide striated limb. The axis extends to the margin of the latter, whilst the pleural segments are broad and flat. In *Barrandia* both axis and the divisions of the pleuræ are quite apparent, but in *Stygina* the axis is, in fact, of the two, the more prominent; the pleural segmentation is hardly to be noticed.

In the Illænidæ, having for the type genus *Illænus* itself, the caudal shield is large in proportion to the thorax, seldom, if ever, segmented—if the rudimentary axis be left out of consideration—certainly very rarely on the pleuræ, and always convex and prominent. One of the few examples of segmentation on the pygidium in *Illænus*, known to me, is that of *I. atavus*, Eichwald* and even in this instance it is very slight.

In the Bronteidæ the tail is usually of large size in comparison with the thorax, strongly sub-semicircular, or deeply fan-shaped;

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* Holm, Mém. Acad. Imp. Sci. St. Pétersbourg, 1886, xxiii., t. 7, f. 4ª

the axis short and rudimentary; the coalesced pleural segments flat, broad, and typically seven to eight on either side, with a peculiar downward curve very characteristic of the genus. In many species the limb is also wide and well-marked.

Of the three families thus selected by elimination, the Illænidæ may, I think, be discarded, leaving only the Asaphidæ and Bronteidæ to choose from.

Now, however obliquely distorted Trilobite pygidia may be, take for instance the Asaphidæ of the Tremadoc Group, amongst Lower Silurian forms, the axis is invariably perceptible to a greater or less extent; and, had there been such an axis on Mr. Sweet's specimen, some trace of it would be visible, notwithstanding the adherent matrix, more particularly towards the apex. This, it seems to me, debars the entry of this fossil amongst the Asaphidæ; although, it must be admitted, excepting this character, and the absence of anterior lateral fulcral-facets, the present fossil has a general resemblance to some of the *Asaphi* proper, particularly such species as *Asaphus centralis*, Conrad.*

With regard to the Bronteidæ, and a comparison with this fossil, we are met at the outset with the same axial difficulty. The small lobiform axis is usually a prominent feature, and should have left some evidence of its presence, especially along the anterior margin, although the specimen has certainly been damaged here by blows from the hammer. There should likewise have been traces of the long terminal appendage as a continuation towards the apex of the pygidium, and the anterior fulcral-facets, but both are conspicuous by their absence. The only remaining feature on which to effect a comparison is that of the coalesced pleural segments, and these are certainly more Bronteiform than *Asaphus*-like. In *Asaphus* and *Ogygia*, the coalesced segments are sometimes grooved and at other times not, but the angle that each segment forms with the median axial line is an obtuse one, at any rate in the anterior portion, and the whole radiate, as it were, from the axis throughout its entire length. In *Bronteus*, on the other hand, the similar angle is acute, the segments, in consequence of their trend from the small axial lobe at the anterior end of the pygidium, have a much greater backward

* Whitfield, Bull. American Mus. Nat. Hist., 1889, ii., No. 2, t.12.

Art. XV.—*The largest Australian Trilobite hitherto discovered.*

(With Plate XI.)

By R. Etheridge, Junr., Corr. Member.

[Read 14th December, 1893.]

Amongst a large suite of interesting fossil organic remains discovered by Mr. George Sweet, F.G.S., at Delatite, is what I take to be a large ill-preserved Trilobite pygidium, at any rate I can see no other feasible explanation of the specimen. It consists of a Crustacean plate on the surface of a piece of flaggy calcareous shale, compressed flat, and somewhat obliquely distorted. In its original condition, it must have been sub-semicircular, and rather acuminate posteriorly, six inches across the anterior, or pygidio-thoracic edge, and with the lateral angles rounded. The longitudinal (oblique) measurement is four and a half inches, but in the undistorted state this would probably represent about five inches. On the left hand side, when facing the observer, are five coalesced pleural segments, probably portion of a sixth, and possibly a seventh, the two last very faintly preserved. On the right hand side four only are visible, as the remainder are hidden by an intractable coating of matrix, which also obscures any trace of axial segmentation. If, therefore, my conception of this fossil be correct, it exhibits, as it should do, and allowing for the oblique distortion it has undergone, bilateral symmetry. It is unfortunate that the central portion is so completely hidden by matrix that cannot be removed, for on the axial features, the question of generic identity depends. The entire surface is minutely pitted; and the point that appears to represent the apical centre, or centre of the posterior margin, is apparently emarginate.*

The principal points which militate against the Trilobite nature of our fossil are: (1) the absence of any trace of axial

* Too much stress, however, cannot be laid upon this point, owing to the condition of the specimen.

segmentation, notwithstanding the adherent matrix; (2) the absence of any trace of a limb, or striated margin posteriorly or laterally; and (3) the presence of the apical emargination. There is, on the other hand, a definite thread-like margin round the sides and hinder portion, which at once dispels the idea that the plate might be a portion of some other organism; and I think that the lateral segmentation radiating outwards on both sides places its identity, so far as the generalised systematic position is concerned, beyond doubt, but a reference to some one of the known genera is a more difficult task. Perhaps the easiest method of arriving at a decision on this point will be by a process of elimination. The characters, so far as they can be deciphered, at once forbid the entrance of the fossil within the families of the Harpedidæ, Remopleuridæ, Olenidæ, Conocephalidæ, Calymenidæ, Æglinidæ, Cheiruridæ, Encrinuridæ, Didymenidæ, Acidaspidæ, Lichadidæ, Phacopidæ, Proetidæ, Trinuclidæ, and Agnostidæ, thus leaving the Asaphidæ, Bronteidæ, and Illænidæ to choose from.

In the Asaphidæ, *Asaphus* and *Ogygia* being the typical genera, the caudal shield is often of large size, and in some species of the former obscurely segmented, but in other *Asaphi* both the axis and pleural segments are well defined. In *Ogygia* the tail is wide transversely, with a wide striated limb. The axis extends to the margin of the latter, whilst the pleural segments are broad and flat. In *Barrandia* both axis and the divisions of the pleuræ are quite apparent, but in *Stygina* the axis is, in fact, of the two, the more prominent; the pleural segmentation is hardly to be noticed.

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* Holm, Mém. Acad. Imp. Sci. St. Pétersbourg, 1886, xxiii., t. 7, f. 4*

the axis short and rudimentary; the coalesced pleural segments flat, broad, and typically seven to eight on either side, with a peculiar downward curve very characteristic of the genus. In many species the limb is also wide and well-marked.

Of the three families thus selected by elimination, the Illænidæ may, I think, be discarded, leaving only the Asaphidæ and Bronteidæ to choose from.

Now, however obliquely distorted Trilobite pygidia may be, take for instance the Asaphidæ of the Tremadoc Group, amongst Lower Silurian forms, the axis is invariably perceptible to a greater or less extent; and, had there been such an axis on Mr. Sweet's specimen, some trace of it would be visible, notwithstanding the adherent matrix, more particularly towards the apex. This, it seems to me, debars the entry of this fossil amongst the Asaphidæ; although, it must be admitted, excepting this character, and the absence of anterior lateral fulcral-facets, the present fossil has a general resemblance to some of the *Asaphi* proper, particularly such species as *Asaphus centralis*, Conrad.*

With regard to the Bronteidæ, and a comparison with this fossil, we are met at the outset with the same axial difficulty. The small lobiform axis is usually a prominent feature, and should have left some evidence of its presence, especially along the anterior margin, although the specimen has certainly been damaged here by blows from the hammer. There should likewise have been traces of the long terminal appendage as a continuation towards the apex of the pygidium, and the anterior fulcral-facets, but both are conspicuous by their absence. The only remaining feature on which to effect a comparison is that of the coalesced pleural segments, and these are certainly more Bronteiform than *Asaphus*-like. In *Asaphus* and *Ogygia*, the coalesced segments are sometimes grooved and at other times not, but the angle that each segment forms with the median axial line is an obtuse one, at any rate in the anterior portion, and the whole radiate, as it were, from the axis throughout its entire length. In *Bronteus*, on the other hand, the similar angle is acute, the segments, in consequence of their trend from the small axial lobe at the anterior end of the pygidium, have a much greater backward

* Whitfield, Bull. American Mus. Nat. Hist., 1889, ii., No. 2, t.12.

curvature than in the two genera named. Furthermore, the segments are entire, and without grooves, separated by intercostal spaces of greater or less width, and there are no well-marked anterior facets. On these grounds, therefore, I am led to regard the present fossil as more properly appertaining to the Bronteidæ, and possibly referable to *Bronteus* itself.

Indefinite and broad pleural segments are common to many species of *Bronteus*, becoming obsolete near the margin of the pygidium. The median appendage, however, connecting the apex of the abbreviated axis with the similar point on the posterior margin of the caudal shield is nearly always present, and generally bifurcate. No better example of such ill-defined pleuræ can be adduced than that of *B. senescens*, Clarke,* although very broad segments are also present in the typical *B. flabellifer*, Goldf.† Segments of similar width, and equally lacking in definition, may also be seen in *B. campanifer*, Barr;‡ indeed in some cases they become more like broad flat folds than segments, such as those of *B. Laphami*, Whitf.§ Another point which must be taken into consideration in attempting to decipher this fossil is the alteration in appearance caused by the successive peeling-off of layers of test, the segments becoming fainter and fainter as the process goes on. This may be seen in Barrande's figures of *B. palifer*, Beyr,‖ and *B. angusticeps*, Barr.¶

In regarding this pygidium as that of a *Bronteus*, there are two negative points that have to be considered. In the first place there is not the slightest trace of the projecting anterior end, or perhaps segment, of the axis, which is usually seen in this genus to protrude beyond the general fore-margin of the shield, although I have previously suggested an explanation of this. In the second place the hinder-margin seems to be emarginate, excentrically in the specimen's present state it is true, but in a position that would, in all probability, represent the middle line of the caudal shield, were it not for the distortion it has undergone. I know of no *Bronteus* with such

* Forty-second Report Trustees State Cab. Nat. Hist. New York for 1888 [1889], p. 403.

† De Koninck, Mém. Acad. R. Bruxelles, xiv., 1st pl., f. 1.

‡ Syst. Sil. Bohême, I., Atlas t.44, f. 6 and 8.

§ Geol. Wisconsin, Survey 1873-79, iv., 1882, p. 310, t. 22, f. 3.

‖ Barrande, *loc. cit.*, t. 45, f. 11.

¶ *Loc. cit.*, t. 45, f. 27.

an apical break in the outline of its tail, although it is not unknown in the genus *Lichas*. These points certainly weigh against the reference of Mr. Sweet's fossil to *Bronteus*, but it is a matter for consideration, whether or no they are outweighed by those points that may be considered in favour of such a reference. The largest *Bronteus* of which I have any record is *B. Laphami*, Whitf,* with a tail measuring four inches broad, by four and a half long; and the next is *B. viator*, Barr., a tail of which, figured by Novák†, measures three and a quarter inches in length by three and a half in width. The largest described Australian *Bronteus* in *B. Jenkinsi*, E. and M.,‡ but even this, compared to the present form, is a mere pigmy.

From the point of size merely, this pygidium must represent a Trilobite well-fitted to hold its own amongst some of the largest known. For instance, taking for comparison our hitherto largest Australian *Bronteus*, *B. Jenkinsi*, we find that a pygidium possessing a length of one and a half inches represents an entire body of nearly three and a half inches. The length of our present specimen, allowing for distortion, is five inches, therefore, in the same degree of proportion, the full body would be as near as possible a foot long.

Turning to the existing record of large Trilobites we find that the *Paradoxides Tessini*, Linn.§, is twelve inches in length, the almost equally large *P. Forchammeri*, Angelin‖, is ten inches in length, whilst the immense *Asaphus (Megalaspis) heros*, Dalman¶, is fourteen inches long. Mr. F. Bayan estimates that the total length of *Lichas Heberti*, judging by the size of the cephalic shield, must have been, in round numbers, between two feet and two feet six inches long**. Many other instances might be cited, including the British *Paradoxides Davidis*, Salter††, which is thirteen inches in length; and the American *Dalmanites (Coronura) mymecophorus*, Green, figured by Hall and Clarke‡‡,

* Geol. Wisconsin Survey, 1873-79, 1882, iv., p. 310, t. 22, f. 3.
† Beiträge Pal. Ost.-Ungarns, Heft. 1 and 2, 1883, t.11, f.16.
‡ Proc. Linn. Soc. N.S. Wales, 1890, v. (2), p. 502, t. 18.
§ Angelin and Lindström, Pal. Scandinavica, Pt. 1, 1878, t. 1
‖ Angelin and Lindström, Pal. Scandinavica, Pt. 1, 1878, t. 2.
¶ Angelin and Lindström, Pal. Scandinavica, Pt. 1, 1878, t. 3.
** Bull. Soc. Géol. France.
†† Brit. Organic Remains, Dec. xi., 18 , t. 10.
‡‡ Pal. New York, 1888, vii., t. 15.

fourteen and a quarter inches in length. Those interested in the proportions of these gigantic Trilobites will find full data in an interesting paper recently published by Mr. J. M. Clarke,* enumerating many others than those here given, not the least interesting being the gigantic *Tretaspis grandis*, Hall†, which is believed to have attained two feet in length. Mr. Clarke remarks on this—"A size unsurpassed and unequalled by any other known Trilobite," but if Mr. Bayan's estimate of *Lichas Heberti*, Rouault, be correct, we have there a larger one.

In conclusion, believing as I do, that the fossil represents the pygidial remains of a large Trilobite related to, if not identical with the genus *Bronteus*, I suggest for it, with the view of future reference, the name of *Bronteus? enormis*, in relation to its size. With regard to its age it is certainly Lower Palæozoic, but I have not yet seen sufficient of the accompanying fossils to be in a position to express a more definite opinion.

DESCRIPTION OF PLATE XI.

Fig. 1. *Bronteus? enormis*, Eth. fil. Pygidium of the natural size, slightly obliquely distorted.

Fig. 2. Portion of the surface enlarged.

* 44th Ann. Report New York State Mus. for 1890 [1892], p. 111.

† *Loc. cit.*, pl. opp. p. 114.

Fig. 1.

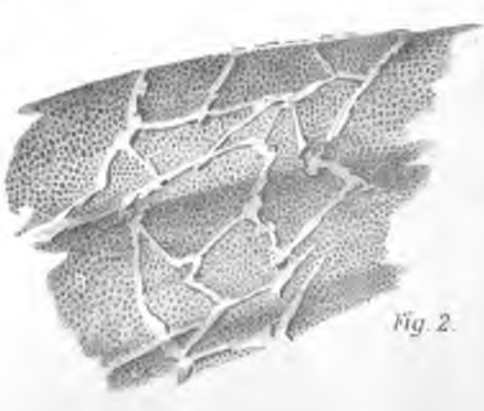

Fig. 2.

Art. XVI.—*Preliminary Survey of Eucalyptus-Oils of Victoria.*

By W. Percy Wilkinson.

[Communicated by C. R. Blackett, Esq., F.C.S., &c., 14th December, 1893].

Only of recent years have the Eucalyptus-Oils, both in their purely chemical and commercial aspects, been receiving the attention they deserve, considering that large tracts of the continent of Australia are covered with forests of the Eucalypts, including more than 134 species (Baron F. von Mueller, 2nd *Systematic Census of Australian Plants*, Part I., 1889; *Eucalyptographia*, 1879-1884), many of which yield much volatile oil. Hitherto the oils have been investigated almost exclusively in Europe, where however only limited varieties of the oils have been accessible; so it seemed to me that, as a detailed examination of certain typical oils was being carried out by European chemists, the most advantageous work to begin on in Australia would be a general preliminary examination of the oils from as many distinct Eucalypts as possible. Accordingly eighty-seven samples were gathered (practically all in Victoria), some from the Botanic Garden Museum, some from the Pharmaceutical Society's Museum, and the rest directly from the distilleries, which during the last few years have increased greatly in number. It was an essential part of the inquiry to ascertain the botanical source of as many of the oils as possible, and in a number of cases it has been with great kindness determined by Baron F. von Mueller, our distinguished Government Botanist, on specimens submitted to him. For the purposes of a general preliminary examination it was desirable to select a few definite physical properties capable of exact measurement for defining and differentiating the oils, and the density, specific rotation, refractive index and specific refractive energy were chosen as most suitable; the boiling points of the oils were not taken, as their range is small, and because the boiling points of mixtures such as these oils is not a satisfactory physical constant. The only chemical test applied

to all the oils has been Cahours' nitrite reaction for Phellandrene (*Ann. der Chem.* 41, p. 76), as modified by Bunge (*Zeit. für Chem.* 5.; *Bull. Soc. Chim.* 1870, pp. 272-273) and Wallach and Gildemeister (*Ann. der Chem.* 246, p. 282).

The densities were taken with a pyknometer holding about 25 grammes of water, and in each case at 15°C., referred to water at 15°C. The specific rotation was measured in a column of liquid 10 c.m. in length at 15°C., using the Sodium-flame; if a is the angle of rotation and d the density, then the specific rotation in the usual notation is

$$[a]_{D} = \frac{a}{d}.$$

The refractive index was measured at 20°C. for the D line of Sodium with a spectrometer read to minutes but not to fractions of a minute, the index in each case being calculated from three independent measurements of the angle of deviation δ according to the usual formula

$$\mu = \frac{\sin.\ \frac{A+\delta}{2}}{\sin.\ \frac{A}{2}}$$ where A is the angle of the prism.

To obtain the specific refractive energy $\frac{\mu_D - 1}{d}$ at 20° $\left(\frac{\mu - 1}{d}\right.$ being only slightly variable with temperature$\left.\right)$, the densities at 20° were calculated from those determined at 15° by means of the formula $d_{20}° = d_{15}°(1 - 5b)$ where b is the coefficient of change of density of the oil for 1°C.; b was determined for four oils by means of measurements of their densities at 15° and 100°C. as now given.

TABLE I.

$d._{15}°$	$d._{100}°$	b
·8532	·7846	·000945
·8753	·8072	·000916
·9134	·8411	·000931
·9213	·8481	·000934
	Mean. ...	·000931

The values of the physical constants are given in the following table for the 87 Eucalyptus-Oils, arranged in the order of ascending density :—

TABLE II.

EUCALYPTUS-OILS.

Progressive Number.	Botanical Source.	Density 15°/15°	Specific Rotation $[\alpha]_D^{15°}$	Refractive Index $\mu_D^{20°}$	Specific Refractive Energy $\frac{\mu_D - 1}{d}$	Phellandrene Reaction.
1	E. amygdalina - -	·8532	−88·9°	1·4758	·5603	P
2	,, ,, - -	·8544	−82·5°	1·4765	·5603	P
3	,, ,, - -	·8560	−80·7°	1·4758	·5584	P
4	,, ,, - -	·8561	−73·9°	1·4769	·5596	P
5	,, ,, - -	·8568	−81·1°	1·4781	·5606	P
6	,, ,, - -	·8582	−71·1°	1·4769	·5583	P
7	,, ,, - -	·8625	−69·5°	1·4813	·5606	P
8	,, ,, - -	·8641	−63·6°	1·4789	·5570	P
9	,, ,, - -	·8695	−68·5°	1·4829	·5580	P
10	,, ,, - -	·8726	−36·2°	1·4725	·5439	P
11	,, citriodora - -	·8745	0·0°	1·4527	·5200	N
12	,, amygdalina - -	·8750	−35·9°	1·4745	·5447	P
13	,, ,, - -	·8753	−56·3°	1·4813	·5524	P
14	,, ,, - -	·8767	−68·4°	1·4785	·5483	P
15	,, ,, - -	·8777	−84·0°	1·4777	·5467	P
16	,, ,, - -	·8789	−44·6°	1·4749	·5428	P
17	,, ,, - -	·8806	−42·6°	1·4717	·5381	P
18	,, citriodora - -	·8817	−58·4°	1·4793	·5461	P
19	,, dumosa - - -	·8842	+ 0·6°	1·4701	·5341	S.pt.
20	,, amygdalina - -	·8884	−55·7°	1·4761	·5383	P
21	,, ,, - -	·8893	−16·3°	1·4713	·5323	P
22	,, ,, - -	·8894	−70·8°	1·4789	·5410	P
23	,, ,, - -	·8894	−64·9°	1·4757	·5373	P
24	,, ,, - -	·8908	−56·1°	1·4797	·5410	P
25	,, ,, - -	·8925	−35·3°	1·4829	·5435	P
26	,, ,, - -	·8940	−22·4°	1·4693	·5273	P
27	,, ,, - -	·8942	−17·8°	1·4701	·5281	P
28	,, pauciflora - -	·8943	+16·7°	1·4629	·5200	N
29	,, globulus - -	·8958	+17·3°	1·4641	·5205	N
30	,, amygdalina - -	·8967	−59·9°	1·4869	·5454	S.pt.
31	,, cneorifolia - -	·8991	−13·3°	1·4677	·5226	S.pt.
32	,, oleosa - - -	·9066	+ 5·5°	1·4624	·5124	N
33	,, cneorifolia - -	·9071	−12·1°	1·4705	·5211	N
34	,, Mallee (mixed var.) -	·9081	+ 5·5°	1·4580	·5067	N
35	,, gracilis - - -	·9090	+ 9·3°	1·4612	·5097	N
36	,, globulus - -	·9120	+ 1·1°	1·4596	·4952	N
37	,, rostrata - -	·9120	+ 8·7°	1·4604	·5072	N
38	,, globulus - -	·9125	+ 3·8°	1·4612	·5077	N
39	,, ,, - -	·9127	+ 4·9°	1·4632	·5098	N

Progressive Number.	Botanical Source.	Density 15°/15°	Specific Rotation $[\alpha]_D$ .15°	Refractive Index $\mu._D^{20°}$	Specific Refractive Energy $\frac{\mu_D - 1}{d}$	Phellandrene Reaction.
40	E. piperita - -	·9133	+ 1·6°	1·4592	·5051	N
41	„ Mallee (mixed var.) -	·9134	+ 2·7°	1·4608	·5068	N
42	„ globulus - -	·9142	+ 1·1°	1·4793	·5465	S.pt.
43	Eucalyptol - -	·9143	+ 4·1°	1·4608	·5063	N
44	E. Mallee - - -	·9145	+ 3·8°	1·4608	·5062	N
45	„ amygdalina - -	·9148	– 3·3°	1·4612	·5064	N
46	„ globulus - -	·9152	– 6·2°	1·4580	·5027	N
47	„ dumosa- - -	·9152	+ 6·8°	1·4624	·5074	N
48	„ Leucoxylon - -	·9154	+ 0·7°	1·4634	·5085	N
49	„ oleosa - - -	·9155	+ 5·2°	1·4629	·5080	N
50	„ dumosa - -	·9159	+ 6·5°	1·4829	·5296	N
51	Eucalyptol - -	·9161	+ 3·8°	1·4616	·5062	N
52	E. Leucoxylon - -	·9164	+ 0·5°	1·4596	·5037	N
53	„ amygdalina - -	·9168	– 35·9°	1·4801	·5260	P
54	„ Stuartiana - -	·9175	– 7·1°	1·4709	·5156	N
55	„ (mixed var.) - -	·9175	+ 4·9°	1·4616	·5054	N
56	„ (mixed var.) - -	·9192	– 2.2°	1·4624	·5053	N
57	„ globulus - -	·9196	+ 2·2°	1·4596	·5020	N
58	„ goniocalyx - -	·9197	– 4·3°	1·4705	·5140	N
59	„ globulus - -	·9197	+ 4.4°	1·4632	·5060	N
60	„ pauciflora - -	·9200	+ 6·0°	1·4604	·5027	N
61	„ citriodora - -	·9200	0·°	1·4612	·5036	N
62	„ cneorifolia - -	·9200	– 2·7°	1·4640	·5066	N
63	„ globulus - -	·9202	+ 2·7°	1·4592	·5013	N
64	„ „ - -	·9207	+ 2·7°	1·4612	·5032	N
65	„ (mixed var.) - -	·9209	+ 0·5°	1·4649	·5071	N
66	Eucalyptol - -	·9213	+ 3·8°	1·4604	·5020	N
67	E. cneorifolia - -	·9215	– 5·4°	1·4652	·5071	S.pt.
68	„ rostrata - -	·9216	+ 2·2°	1·4600	·5014	N
69	Eucalyptol - -	·9221	+ 5·9°	1·4559	·4965	N
70	E. cneorifolia - -	·9221	– 4·1°	1·4640	·5055	N
71	„ rostrata - -	·9222	+ 0·5°	1·4607	·5018	N
72	„ Lehmanni - -	·9236	+ 5·9°	1·4616	·5021	N
73	„ occidentalis - -	·9236	+ 2·7°	1·4628	·5034	N
74	„ diversicolor - -	·9240	+ 9·7°	...	...	N
75	„ globulus - -	·9265	+ 3·2°	1·4624	·5013	N
76	„ oleosa - - -	·9267	Too dark to observe	1·4729	·5126	N
77	„ Leucoxylon - -	·9271	+ 2·7°	1·4608	·5000	N
78	„ fissilis - - -	·9282	0°	1·4592	·4970	N
79	Black Oil (Redistilled) -	·9311	– 41·8°	1·4845	·5226	S.pt.
80	E. Stuartiana - -	·9327	– 16·6°	1·4849	·5222	S.pt.
81	Eucalyptol - -	·9341	+ 6·9°	1·4620	·4968	N
82	„ - -	·9382	+ 5·6°	1·4661	·4989	N
83	Black Oil (Redistilled) -	·9403	– 15·9°	1·4877	·5208	S.pt.
84	E. globulus - -	·9430	+ 2·1°	1·4636	·4938	N
85	„ amygdalina - -	·9507	– 5·8°	1·4928	·5205	S.pt.
86	„ globulus - -	·9512	+ 1·6°	1·4628	·4877	N
87	„ amygdalina - -	·9651	– 10·9°	1·4821	·5016	S.pt.

First, as regards density, it will be noticed that it ranges from ·853 to ·965, and if the last five oils, Nos. 83-87 (on account of probable alteration with age) and the two preceding Eucalyptols are omitted, the range is from ·8532 to ·9327, which is not inconsiderable. Separating out the numbers of oils whose densities lie within the ranges ·85 to ·86, ·86 to ·87, and so on, we get

TABLE III.

Density - - -	·85 to ·86	·86 to ·87	·87 to ·88	·88 to ·89	·89 to ·90	·90 to ·91	·91 to ·92	·92 to ·93	above ·93
No. of Oils - -	6	3	7	7	8	4	24	19	9

The first point to notice in this last table is, that up to a density of ·91 the numbers of oils are fairly evenly distributed through the successive intervals of ·01 in density, while at the two higher intervals from ·91 to ·92 and ·92 to ·93 the numbers increase markedly; 35 oils have their density between ·85 and ·91, while 24 have a density between ·91 and ·92, and 19 between ·92 and ·93, so that there is a tendency towards a classification of the oils by density.

Second, as regards specific rotation, it may be stated that on the whole a progressive alteration of the specific rotation accompanies the alterations of density, the lightest oils having the greatest lævo-rotation, which diminishes with increasing density to 0 at about a density of ·907, after which with a few exceptions the oils are slightly dextro-rotatory.

Third, as to refractive index, the alteration here is also progressive, the lighter oils having the higher index, which diminishes with increasing density except in the last few oils, which are altogether exceptional; but the specific refractive energy is much the better form in which to study the relations of the oil to light, and the specific refractive energies of the oils show a range of variation which is larger than that of the density, the values progressing from about ·56 to ·49 (diminishing with increasing density).

Fourth, as to the Phellandrene reaction, it will be seen from the table that all the oils which give the Phellandrene reaction

are of low density and lævo-rotatory, though some few that are lævo-rotatory do not give the Phellandrene reaction.

These results are in harmony with the general conclusions so far obtained in the study of the chemistry of the Eucalyptus-Oils, the chief result of which is to show that these oils contain two main ingredients of different densities, rotation and specific refractive energies; differences in the proportion of the ingredients producing such differences as are recorded in the tables. The researches of Wallach (*Ann. der Chem.*, 225 et seq.; *Ber der Deut. Chem. Ges.*, 24) have established that the two main ingredients are a Terpene or mixture of closely related Terpenes $C_{10}H_{16}$, and Cineol (Eucalyptol) $C_{10}H_{18}O$. The values of the above physical constants for some of these Terpenes and Cineol are approximately as follow, the values of different authorities varying too much to allow of any but approximate values being given :—

TABLE IV.

——		B.Pt.	d_{15°.	$\frac{\mu_D - 1}{d}$
Cineol	- - - - -	176°	·9275	·495
Terpenes -	Limonene -	172° - 179°	·848	·562
	Pinene - -	155° - 160°	·862	·544
	Phellandrene -	170°	·856	·560

The range of density ·848 to ·927 corresponds closely to that pointed out as holding in the natural Eucalyptus-Oils, namely ·853 to ·933, and the range of specific refractive energy is ·495 to ·562, to be compared with the range ·49 to ·56 of the natural oils. Thus it is quite clear that in the Eucalyptus-Oils as a whole we have to do with mixtures in varying proportions of bodies of the two types, Cineol $C_{10}H_{18}O$ and Terpene $C_{10}H_{16}$.

To determine which of the many isomerides possible for both of these types are really present in any one oil, the methods of investigation developed by Wallach will have to be applied; but at present it can be seen that the values of physical constants give a good measure of the relative proportions of the ingredients $C_{10}H_{18}O$ and $C_{10}H_{16}$.

As regards compounds other than $C_{10}H_{18}O$ and $C_{10}H_{16}$ in Eucalyptus-Oils, Sesqui-terpenes $C_{15}H_{24}$ appear to be present, and certain Aldehydes have been observed in quantity sufficient to give a characteristic smell to various oils, and in the case of the oil of *E. maculata* (var. *citriodora*) Citronellal (Citronellon) and Geraniol are present; but the chief work to be done in the immediate future ought to be confined to characterising and isolating the great variety of isomerides of the two main substances $C_{10}H_{18}O$ and $C_{10}H_{16}$. That to do this will be no light undertaking may be gathered from the study of Wallach's work, although he has so simplified the confusion existing as to the number of Terpenes and their derivatives. The closeness of the boiling points of Cineol, Limonene and Phellandrene shows that the method of fractional distillation can give but little help towards even a preliminary separation of a Eucalyptus-Oil into separate chemical compounds; and a brief account of two series of systematic fractionations, carried out on two typical oils, will make this clear. As it is important to realise that other methods of separation will have to be resorted to in working out the chemistry of the Eucalyptus-Oils, as has been done in certain cases by Wallach, the following tables are given to show the amount of separation achieved by a thorough fractionation. Of the two typical oils chosen the first was of the Terpene type, with low density and high negative specific rotation, and the second of the Cineol type, of high density and small positive specific rotation. To secure steadiness in the fractionations a special apparatus was put together, consisting of a copper flask of 350 c.c. capacity, with brazed joints and a neck 12 c.m. long and 19 m.m. diam.; this was inclosed in a cubical chamber of asbestos-millboard of 16 c.m. edge; into the neck of the flask was inserted by means of a thin perforated cork a $\vdash$ tube contracted for insertion in the flask, the large limb of the $\vdash$ tube was 23 m.m. diam. and the side tube 5 m.m. The $\vdash$ tube was enclosed in a wooden chamber with a mica-front, through which could be read the fractionating thermometer divided into $\frac{1}{5}$°C., wholly immersed in the wide limb of the $\vdash$ tube. The burner, which heated the cubical asbestos-chamber, was protected from draughts by a sheet-iron case. The apparatus was found to attain the desired end of

causing the thermometer readings to rise quite steadily during a fractionation.

Of the oil number 1 in Table II., 250 c.c. were twice distilled from calcium chloride to dry it, the end product being clear and almost colourless, with a dark, strongly-smelling residue left in the flask. The physical constants were slightly altered by distillation, the values being

Density	$\cdot 8484^{15^\circ/15^\circ}$
Specific rotation ...	$[\alpha]_D - 85\cdot 4^\circ$
Refractive index	μ_D 1·4769
Sp. ref. energy	·5637

Of the distillate 200 c.c. during one complete fractionating in the above apparatus gave the following fractions, of which the physical constants were determined as before, except the density, which was measured by a Westphal specific gravity balance; some of the fractions were so small that the measurements could not be conveniently made.

TABLE V.

t° C.	Percentage.	Density 15° / 15° C.	$[\alpha]_D$	$\frac{\mu_D - 1}{d}$.
Below 170	·7	...	...	...
170-172	3·7	·845	...	·5600
172-173	5·8	·846	− 84·6°	·5646
173-174	14·5	·846	− 84·0°	·5630
174-175	20·8	·846	− 84·6°	·5641
175-176	19·8	·846	− 88·1°	·5646
176-177	11·5	·847	− 86·3°	·5650
177-178	5·0	·849	− 83·7°	·5645
178-179	5·0	·850	− 81·3°	·5637
179-180	2·5	·854	− 73·3°	·5616
180-185	5·3			
185-195	1·8	...	...	...
Above 195	3·6	...	...	...

These numbers show that a process of separation is going on, as the density increases and the rotation varies with rising boiling point. To see how far this separation could be carried, the 11 individual fractions boiling between 155° and 195°C. were

each redistilled with the same intervals of temperature as before, when the boiling point of the first of the above fractions reached 170°; the second was added, and when the b.p. rose to 172° the third, and so on; the distillates from each fraction being collected for the intervals of temperature given in the following table, which represents the final result after several complete repetitions of the above operations.

TABLE VI.

$t°$ C.	Percentage.	Density 15° / 15° C.	$[\alpha]_D$	$\frac{\mu_D - 1}{d}$
155-170	1·8	...	...	...
170-172	6·3	·844	– 71·8°	·5601
172-173	7·9	·845	– 83·6°	·5610
173-174	9·5	·845	– 84·9°	·5633
174-175	17·5	·847	– 92·2°	·5645
175-176	10·9	·848	– 91·5°	·5648
176-177	14·5	·849	– 87·6°	·5648
177-178	6·8	·849	– 83·2°	·5658
178-179	3·3	·850	...	·5652
179-185	5·4	·853	– 72·4°	·5642
185-195	5·0	·859	– 55·2°	·5606
Above 195	11·1	...	...	...

The process of separation noticed in the first fractionation is still going on, as again indicated by increasing densities and varying rotations. To ascertain how far this separation had gone, the Phellandrene test was applied to the fractions 155 - 170°, 179 - 185°, and 185 - 195° (Wallach and Gildemeister, *Ann. der Chem.*, 246, p. 282). The three fractions gave the Phellandrene reaction strongly, the test tubes presenting a solid mass of crystals of Phellandrene nitrite $C_{10}\ H_{16}.\ N_2\ O_3$.; after washing with water, then absolute methyl alcohol, and crystallising from chloroform, the crystals melted at 103°C. (m. pt. 103° - 104°C. Wallach and Gildemeister, ibid.); this is sufficient to show the practical impossibility of the satisfactory fractional separation of the Terpenes present. Attempts to prepare Bromine addition compounds from the three fractions 170 - 172°, 176 - 177°, and 185 - 195° by Wallach's method (*Ann. der Chem.*, 227, p. 280) were unsuccessful in each case; only oily compounds

separated, which refused obstinately to crystallise even when strongly cooled. The crystalline addition compounds of the Terpenes with two molecules H.Cl. (Wallach, *Ann. der Chem.*, 239, p. 3) could not be obtained from the four fractions boiling at 170 - 172°, 172 - 173°, 174 - 175°, and 179 - 185°, only liquid hydrochlorides resulting. This is in agreement with the experience of Wallach and Gildemeister in their research on *E. amygdalina* oil (*Ann. der Chem.*, 246, pp. 278-284).

The fraction 175 - 176° is of interest on account of its high specific rotation $[\alpha]_D$ − 91·5° and low density ·843; after removing the Phellandrene the remaining oil is still strongly lævo-rotatory, the optical activity being probably partly due to lævo-limonene.

For studying the behaviour of the other type of oil in the fractionating apparatus, a sample of number 34 of Table II. was taken and distilled from calcium chloride with slight alteration of the physical constants as in the last case, the values being :

Density	·909.$^{15°/15°}$
Specific rotation	$[\alpha]_D + 5·5°$.

A slight yellow colour in this oil should be mentioned. Several fractionations on 200 c.c. were carried out in the manner described for the other type of oil. The results of the first and final operations being given in the two following tables :—

TABLE VII.

t°C.	Per-centage.	Density 15° / 15° C.	$[\alpha]_D$.	$\frac{\mu_D - 1}{d}$
160-170	4·0	·898	...	·5150
170-171	11·8	·903	+ 11·6°	·5137
171-172	13·5	·904	+ 10·5°	·5131
172-173	16·8	·907	+ 8·7°	·5114
173-174	13·0	·909	+ 6·2°	·5102
174-175	12·0	·912	+ 4·4°	·5070
175-177	17·3	·915	+ 1·5°	·5055
177-179	6·0	·918	− 0·5°	·5047
179-185	3·5	·919	...	·5054
185-190	1·7	...	...	...
Above 190	0·4	...	...	...

TABLE VIII.

t° C.	Percentage.	Density 15° / 15° C.	$[\alpha]_D$.	$\frac{\mu_D - 1}{d}$
160-170	10·0	·893	+ 18·1°	·5190
170-171	9·5	·897	+ 15·6°	·5166
171-172	7·3	·902	+ 11·7°	·5125
172-173	6·8	·906	+ 9·1°	·5100
173-174	11·8	·910	+ 6·6°	·5072
174-175	11·5	·913	+ 3·7°	·5051
175-177	26·8	·917	+ 1·3°	·5029
177-179	8·0	·920	− 0·9°	·5025
179-185	4·1	·921	− 2·7°	·5408
185-190	1·0	...	...	...
Above 190	2·2	...	...	...

The colour of the original oil appeared almost all in the first fraction 160 - 170°. The result here is as before to show clearly enough that we are dealing with a mixture of substances, the change in the specific rotation from a fairly large positive value at 160 - 170° to a small negative one at 177 - 179° being specially noticeable as accompanying an increase of density. As the oil was chosen as a typical Cineol-oil, the best method of determining how far a separation had been accomplished was to test for Cineol in each fraction according to the method of Wallach (*Ann. der Chem.*, 227, p. 280); in every case the characteristic unstable splendid prismatic crystals of Cineol di-bromide were formed, readily decomposing on exposure to the air.

Dry hydrogen chloride also produced in each of the well-cooled fractions white crystals of the unstable Cineol di-hydrochloride. From the results it will be seen, as in the first type of oil, that we are dealing with a mixture, in which fractionating effects only a limited separation.

On account of the difficulty of separating the two chief constituents of Eucalyptus-Oils by fractional distillation, it seemed to be advisable to use the measurements of the physical constants to obtain at least an approximate estimate of the proportions in which they are present. For instance, in the case of the density, if we assume that an oil is composed of p_1 parts by weight of a mean Terpene of density ·855, and p_2 parts of Cineol of density

·927, and if on mixture the shrinkage is negligible, as in the case of most mixed liquids, then the density d of the mixture is given by

$$\frac{p_1 + p_2}{d} = \frac{p_1}{d_1} + \frac{p_1}{d_2} \quad (1).$$

If $p_1 + p_2$ is 100, then $p_1 = 100 \dfrac{\frac{1}{d} - \frac{1}{d_2}}{\frac{1}{d_1} - \frac{1}{d_2}}$ (2);

so that from the density d it is possible to calculate the percentage by weight p_1 of the Terpene. Of course as a mean value ·855 is adopted for density of Terpene, while the actual densities range from ·848 to ·862; this formula should not be applied to mixtures containing only a small proportion of Cineol. If the Terpene present is known, then in the above formula its density must be taken as d_1; the mean value ·855 being used only when the nature of the Terpene is unknown.

To verify the applicability of the above formula to mixtures of Terpenes and Cineol the following mixtures were made and their densities determined for comparison with those calculated by the formula above.

Mixture I.—Equal volumes of turpentine with $d_1 = ·866$ at 15°C. and Cineol $d_2 = ·9213$ at 15°, density of mixture ·8936 at 15°, calculated value ·8936; the agreement being absolute it follows that formula (2) would give absolutely the percentage of Terpene and Cineol actually mixed.

Mixture II.—Three vols. of turpentine $d_1 = ·866$ and one vol. of oil No. 34. $d_2 = ·9081$ at 15°, density of mixture found $d = ·877$ at 15°, calculated by (1) ·879; conversely using (2) to calculate first the percentage of the two ingredients by weight, we get 26·2 Eucalyptus-Oil and 73·8 of turpentine, which corresponds to one volume of oil to 2·8 of turpentine instead of the 1 to 3 by experiment.

These two experiments show that given an oil consists of only a Terpene and Cineol the proportions of these can be obtained with a certain amount of accuracy by a single determination of the density of the oil, and if the density of the Terpene present is known, then the formula will allow its amount to be determined with fair accuracy by a single determination of the density of the oil.

This determination of the proportions of the two ingredients from the density of the mixture can be controlled by a similar calculation in connection with the specific refractive energy. It is well known, that if r_1 and r_2 are the specific refractive energies of two substances present in proportions p_1 and p_2 by weight and r the sp. ref. energy of the mixture

$$(p_1 + p_2) r = p_1 r_1 + p_2 r_2.$$

$$\text{and } p_1 + p_2 = 100, \text{ then } p_1 = 100 \frac{r - r_2}{r_1 - r_2}$$

According to this formula the sp. ref. energies ought to vary steadily with the densities, if the oils consisted of two main ingredients, and they do vary steadily on the whole, but with marked exceptions, showing that individual oils cannot be taken as mixtures of only the two main substances. By applying the two formulæ (density and sp. ref. energy) to the measurements for an oil, it can be ascertained by the agreement of their results whether the oil is a mixture of a Terpene and Cineol or not.

As another physical constant, whose measurement might be expected to give definite indications as to the proportions of the two main ingredients in a Eucalyptus-Oil, the viscosity seemed promising, as the viscosity of Cineol at ordinary temperatures would naturally be expected to be much larger than that of a Terpene, seeing that it is much nearer its solidifying point; thus, to test the applicability of measurements of viscosity to the analysis of the Eucalyptus-Oils, the following experiments were made.

A cylindrical glass separator of 170 c.c. with a tap at the bottom had 40 c.m. of circular capillary tube connected to it by an india-rubber joint. The whole was so arranged that the capillary hung vertically from the separator, so that its upper end was 30 c.m. from the mark on the neck of the separator to which the oil was filled up in every case. The time was noted for 20 c.c. to run through the capillary; under these circumstances the viscosity is proportional to the time taken and to the density of the liquid; to obtain the specific viscosity referred to, water at 16·5°C. as 100, all that is necessary is to multiply 100 times the time taken by any oil by its density, and to divide by the time for water. The following are the results for certain oils and mixtures:—

TABLE IX.

Substance.	Time in Minutes.	Density 15° /15° C.	Specific viscosity (Water at 16·5° = 100).
Turpentine - - - -	29·0	·866	148
Oil, No. 10 - - - -	31·0	·873	159
„ „ 13 - - - -	30.0	·875	154
„ „ 34, 1 vol. - - } Turpentine, 3 vols. - - }	31·8	·877	164
Oil, No. 15 - - - -	30·0	·878	155
„ „ 34, 1 vol. - - } Turpentine, 1 vol. - - }	33·0	·883	171
Oil, No. 34, 3 vols. - - } Turpentine, 1 vol. - - }	34·0	·889	180
Cineol 1 vol. - - } Turpentine, 1 vol. - - }	38·5	·893	202
Oil, No. 41, 1 vol. - - } „ „ 13, 1 vol. - - }	40·0	·8936	210
„ „ 34 - - - -	40·0	·908	214
„ „ 41 - - - -	57·0	·913	306
No. 66, Cineol - - -	56·0	·921	303

It will be seen, that there is a wide range in the values of the viscosity for the different oils and mixtures, from 148 for turpentine to 303 for Cineol, moreover that a body like oil No. 13, which according to its density and specific rotation must be almost exclusively Terpene (Phellandrene), has the viscosity 154 near that of turpentine, while the oil No. 41, which according to its density contains a large amount of Cineol, also has a large viscosity, viz., 306, which indeed is too large for even pure Cineol, so that probably small amounts of still more viscous substances than Cineol are present. With only slight irregularities the viscosity rises with increasing density. From the densities the amount of Cineol in each oil or mixture can be approximately calculated as already explained, and, as increasing density means increasing content of Cineol, the viscosity rises with increasing content of Cineol.

It thus appears that conclusions drawn as to the composition of an oil from its density and specific refractive energy could be controlled in a general way by viscosity determinations.

APPENDIX.

Bibliography of Recent Literature on the Terpenes and their Derivatives :

Wallach and Brass, *Ann. der Chem.*,	**225.**	1884.	pp.	291-314.
Wallach, „ „	„	„	„	314-318.
„ „ „	**227.**	1885.	„	277-302.
„ „ „	**230.**	„	„	225-272.
„ „ „	**238.**	1887.	„	78-89.
„ „ „	**239.**	„	„	1-54.
„ „ „	**241.**	„	„	315-328.
„ „ „	**245.**	1888.	„	191-213.
„ „ „	„	„	„	241-278.
„ „ „	**246.**	„	„	221-239.
Wallach and Gildemeister, „	**246.**	„	„	265-284.
Wallach, „ „	**252.**	1889.	„	94-140.
„ and Conrady, „	**252.**	„	„	141-157.
„ and Otto, „ „	**253.**	„	„	249-267.
„ „ „	**263.**	1891.	„	129-156.
„ *Ber. der Deut. Chem. Gesell.*,	**24.**	1891.	pp.	1525-1579.
Wallach, *Ann. der Chem.* - -	**264.**	1891.	„	1-32.
„ „ „ - -	**268.**	1892.	„	197-228.
„ „ „ - -	**269.**	„	„	326-376.
„ „ „ - -	**270.**	„	„	171-203.
„ „ „ - -	**271.**	„	„	285-311.
„ „ „ - -	**272.**	1893.	„	99-125.
„ „ „ - -	**275.**	„	„	103-133.
„ „ „ - -	„	„	„	145-183.
„ „ „ - -	**276.**	„	„	296-327.
Brühl, *Ber. der Deut. Chem. Gesell.* - -		1888.	pp.	145-179.
„ „ „ „ - -		„	„	457-477.
„ „ „ „ - -		1891.	„	3373-3416.
„ „ „ „ - -		„	„	3701-3737.
„ „ „ „ - -		1892.	„	142-174.
„ „ „ „ - -		„	„	547-551.
„ „ „ „ - -		„	„	1788-1813.
„ „ „ „ - -		1893.	„	284-292.
Semmler, *Ann. der Chem.* - -	**241.**	1887.	„	90-150.

Semmler, *Ber. der Deut. Chem. Gesell.*	-	1890.	pp.	1098-1103.
,, ,, ,, ,,	-	,,	,,	2965-2968.
,, ,, ,, ,,	-	,,	,,	3556-3557.
,, ,, ,, ,,	-	1891.	,,	201-211.
,, ,, ,, ,,	-	,,	,,	682-685.
,, ,, ,, ,,	-	1893.	,,	2254-2258.
Tilden, *Jour. Chem. Soc. (Trans.)*	-	1875.	,,	514-518.
Tilden and Shenstone, ,,	-	1877.	,,	554-561.
Tilden, ,, ,, ,,	-	1878.	,,	80-88.
,, ,, ,, ,,	-	1879.	,,	286-290.
,, ,, ,, ,,	-	1884.	,,	410-420.
,, ,, ,, ,,	-	1888.	,,	879-888.
Armstrong and Tilden, ,,	-	1879.	,,	733-759.
Gladstone, ,, ,, ,,	-	1864.	,,	1-21.
,, ,, ,, ,,	-	1872.	,,	1-12.
,, ,, ,, ,,	-	1886.	,,	609-623.
Kanonnikoff, *Jour. Prakt. Chemie* -	**32.**	1885.	,,	497-523.
Pesci, *Jour. Chem. Soc. Abst.*	-	1884.	,,	331.
,, *Ber. der Deut. Chem. Gesell.*		1886.	,,	874.
,, and Bettelli, ,, ,, ,,		,,	,,	875.
,, ,, ,, ,,		1889.	,,	108.
,, ,, ,, ,,		1891.	,,	204.
Bouchardat and Voiry, *Compt. Rend.*	**106.**	1888.	,,	663-665.
,, ,, ,,	**116.**	1893.	,,	1253-1255.
,, ,, ,,	**117.**	,,	,,	53-56.
,, and Oliviero, *Bull. Soc. Chim.*		,,	,,	429-432.
Barbier, *Compt. Rend.*,	**114.**	1892.	,,	126-128.
,, ,, ,,	**116.**	1893.	,,	883-884.
,, ,, ,,	,,	,,	,,	993-994.
,, ,, ,,	,,	,,	,,	1062-1064.
,, ,, ,,	,,	,,	,,	1200-1202.
,, ,, ,,	,,	,,	,,	1459-1461.
,, ,, ,,	**117.**	,,	,,	120-122.
,, ,, ,,	,,	,,	,,	177-178.
Husemann, *Die Pflanzenstoffe.* - -	-	1884.		
Bornemann, *Die flüchtigen Oele des Pflanzenreiches* - - -	-	1891.		

Art. XVII.—*Report of the Antarctic Committee of the Royal Society of Victoria.*

[Read 16th November, 1893.]

Your Committee has held a few meetings during the year, sitting with the corresponding Committee of the Royal Geographical Society of Australia, as hitherto. There has been very little work to do since Baron Dickson decided to withdraw his co-operation in the proposed Swedish-Australian expedition to have been despatched in the charge of Baron Nordenskiöld. Nevertheless, our efforts to direct attention to this region have, during the past year, borne their first fruits in the despatch of five steam whalers. These vessels carried a limited staff of observers and the scientific work done was subordinated very strictly to the commercial purposes of the owners of the ships. The vessels having found a plentiful supply of seals in latitude 64° S., under the lea of Trinity land, went no further south. Dr. Donald and Mr. W. S. Bruce have written important papers descriptive of their observations on board the *Balæna* and *Active*, and these will shortly be published by the Royal Geographical Society of Great Britain. A fine collection of southern birds has been brought back, and a collection of drawings and photographs which was exhibited at the last meeting of the British Association attracted considerable attention, and has led to a vote of money to enable Mr. Bruce to spend next year upon one of the Antarctic Islands making further observations.

As the owners of the ships are sending them out again this year it may be concluded that the cargoes brought home last year were of a sufficiently payable nature to ensure further exploration of the region for commercial purposes. Further, we shall shortly be able to record an effort to re-open the Antarctic on the meridian of Australia or New Zealand, as a steam whaler, the *Antarctic*, left Tonsberg in Norway on 19th September, under the command of Captain Bull. She will go direct to Newcastle N.S.W., where she will fill her bunkers and then start for the

south. A small bonus from our Government would induce her owners to allow her to return with her cargo to Melbourne, and thus to initiate the new industry which we have long sought to get our local shipowners and merchants to embark in—so far without success. Efforts should also be made to secure a passage for a scientific observer, whose work need not impede the work of the voyage whilst it should be of the greatest scientific value.

We must congratulate the Society upon the efforts made by the joint Committee during the past seven years, as they have resulted in the re-opening of the Antarctic Seas, after fifty years of absolute neglect.

G. S. GRIFFITHS,

Hon. Secretary Antarctic Sub-Committee.

Art. XVIII.—*Report of the Gravity Survey Committee of the Royal Society of Victoria.*

[Read 16th November, 1893.]

Your Committee has much pleasure in reporting that good progress has been made in the work of the Survey during the past year. The apparatus sent out from the Kew Observatory by the Royal Society of London has been erected at the Melbourne Observatory in an underground apartment, under the supervision of Mr. Ellery; the observing telescope described in the last report was completed and placed in position last autumn: and an elaborate series of observations taken of the pendulums by Mr. Baracchi, in order to connect Melbourne with the Kew and Greenwich base stations.* Mr. Love has obtained practice in observing, and is now engaged on a series of observations intended partly to supplement those of Mr. Baracchi, partly to form a starting point for the Australasian Survey.

In the course of the work a number of—as the observers think—radical defects in Kater's design for an invariable pendulum have manifested themselves (see appendix). It is hoped that some of these disadvantages will be overcome in the new type of pendulum now under construction by Mr. Ellery at the Melbourne Observatory.

The Committee has expended £12 6s. of its grant, partly cost of package and transport of the pendulums, partly in necessary mechanical work upon them.

Your Committee respectfully asks for re-appointment, with the addition of the name of Mr. Baracchi; and that the unexpended balance of the grant of £25 be placed at its disposal.

E. F. J. Love, *Hon. Sec.*

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* Proc. Roy. Soc. Victoria, vol. vi., p. 162.

Appendix A.

On the design of Pendulum Apparatus for Differential Observations of Gravity. By E. F. J. Love, M.A.

The work of the Gravity Survey Committee, of which I have the honour to be secretary, has forced upon my attention the subject of the various theoretical points which come up for consideration in the designing of pendulums for use in differential observations of gravity. A good many different forms of pendulum are now employed for this purpose by observers in different parts of the world: and it seems not altogether without interest to examine the various types in use, with the view of seeing to what extent they agree with what we may look upon as the ideal pendulum, and, where they differ, to indicate the manner in which improvements might be effected.

(a) The first point to which attention should be directed is the fact that the only measurement which has to be made on pendulums for differential work is the determination of the vibration number in different parts of the earth. This at once places the possible accuracy of the work on an altogether different level from that obtainable in any absolute measurement of gravity: in absolute measurement we are definitely limited by the degree of accuracy obtained in the measurement of the length of the pendulum, an operation very inferior in this respect to the determination of a vibration number by the method of conicidences. But the whole value of the work depends on the extent to which the vibration number of the differential pendulum at any one place maintains its constancy; in other words, *on the degree of invariability of the pendulum.*

It might seem superfluous to insist on the necessity of so constructing a differential pendulum that it shall be, as far as the nature of material structures will allow, invariable in form and dimensions, but such is not the case. Some observers have conceived the idea that it would be convenient to be able to make both differential and absolute measurements with the same pendulum: notably Commandant Defforges,* who has con-

* Comptes-Rendus des séances de la Commission Permanente de l'Association Géodésigne Internationale, 1888. Annexe vb. p. 12, *egg.*

structed for use in the French geodetic surveys an instrument which he terms a "reversible invertible pendulum:" this instrument has two fixed knife-edges, and two interchangeable weights, which are transferred from end to end of the pendulum in each observation. Commandant Defforges is of opinion that such a mode of construction will do away with the errors inseparable from the use of so-called invariable pendulums. I cannot agree with him here: for it seems to me very doubtful whether we should ever get the weights after displacement back to exactly their original positions: and the errors thus commissible, though small, are quite likely to be of a higher order of magnitude than those which the method is designed to eliminate. For instance, suppose a fine dust particle should get lodged between the weight and its seat: this might well be the ten-thousandth of an inch thick, and yet escape observation: yet it would alter the vibration number in a half-seconds pendulum by one and a half vibrations per day. Moreover, the large amount of extra handling, screwing up, etc., involved seems to me to militate seriously against the trustworthiness of the arrangement. I have entered into this matter at considerable length because Commandant Defforges is looked upon, and rightly so, as one of the foremost of living geodesists, and his work demands very careful consideration.

Positing then the necessity for invariability, as far as it can be attained, let us see how we are to seek it.

I am strongly of opinion that the pendulum should be rigid; this, indeed, was the first point forced on my attention when handling the Indian pendulums. However much care be taken, a five-foot bar of thin brass, with comparatively heavy weights at its ends, is continually undergoing flexures of a rather alarming magnitude during the processes of handling which necessarily go on in the course of the transfer of the pendulum from its case to the cylinder in which it is vibrated; I have serious doubts whether any amount of care can prevent such flexures as will introduce a permanent set and alter the vibration number. Nor are these doubts without solid foundation; we know that these pendulums have been bent in the past, and have had to be re-straightened—a process which necessarily destroys the continuity of the observations made with them—and one of them is certainly not quite straight

now. On these grounds I should view with suspicion any design which included a flexible bar; among these may be mentioned the pendulums lately employed by Professor Mendenhall,* which were of the same general pattern as the Indian pendulums, though much shorter, and consequently less liable to injury. The best pattern I have seen is that adopted by Lieut.-Col. von Sterneck, which consists of a rigid rod, carrying at its lower end a bob composed of two frustra of cones united at the base.

Recent practice inclines more and more, and rightly so, to the use of half-second pendulums; for a pendulum of one-fourth the length is, at least, ten times as free from risk of injury in handling. A five-foot bar is distinctly awkward, but a thirteen-inch bar is just about as comfortable a size to handle as could well be imagined, to say nothing of the increased rigidity. This method secures the further advantage of portability, a matter of great importance in survey work.

Not merely should the pendulum be short and rigid, its structure should be, as far as possible, continuous throughout. This, unfortunately, cannot be fully attained; the best which can be done is to have the different parts so made that they can be attached together by a process of shrinking on and riveting. Solder is always objectionable, and its use can be avoided by employing a suitable design.

One great obstacle to the attainment of invariability is the old practice of attaching the knife-edges to the pendulum and swinging it on a plane suspension; for the knife-edges get dulled and have to be reground; each regrinding of course changes the effective length of the pendulum, and destroys the differentiality of the observations. Professor Mendenhall† took a great step in advance when he attached the planes to the pendulum, and swung it on a knife-edge suspension: for a good agate plane requires only to be kept clean; while the knife-edges, if separate from the pendulum, may be reground at pleasure without sacrifice of differentiality. Incidentally this mode of suspension introduces a good many other improvements, which may as well be summarised here.

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* U.S. Coast and Geodetic Survey Report for 1891, appendix 15, p. 503.

† *L.c.*, p. 530.

1st. The difficulty of setting the knife-edges accurately in line is entirely got rid of; for they can be attached, once for all, to their seats in the suspending apparatus, and ground up together *in situ.*

2nd. The difficulty, never yet overcome, of setting the knife-edges accurately perpendicular to the axis of the pendulum is done away with: for the setting of the agate planes can be tested by optical means to any required order of accuracy, and the head to which the planes are attached can be altered till they attain their proper positions. This fact removes the only possible advantage of a flexible pendulum bar. Kater's object in making the bar flexible was to ensure its verticality even if the knife-edges were not quite accurately set; this advantage has always seemed to me rather a doubtful one,* even with Kater's original pattern, but whether it be so or no, the attachment of the agate planes to the pendulum makes any flexibility in the bar quite superfluous.

(b) Not merely should the pendulum be invariable, its shape is a matter of importance; for it must be so designed as to render the resistance of the air to its motion a minimun. This is a serious objection to a form which would otherwise be highly advantageous; Captain Basevi† suggested that a rigid cylindrical rod with a spherical bob would be a good form, because for it, alone of all known figures, the pressure connection could be determined directly by calculation; unfortunately this form offers a great deal of air resistance, and such a pendulum would have its oscillations damped too rapidly for convenient observing. A lenticular figure is probably the best, but it is difficult to make symmetrical; and on the whole, the most convenient seems to be the double-cone pattern of von Sterneçk, which can be figured in the lathe with all desired accuracy.

Another point in connection with the shape is the position to be assigned to the pendulum bob. The usual practice is to set its broadest plane vertical and in the plane of swing; but von Sterneck puts it horizontal. I believe this was done by him for constructional reasons, but a further advantage is incidentally secured in this way. It is well known that a flat body moving in a fluid

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Sir G. G. Stokes however thinks differently. *Vide* appendix B.

† G. T. Survey of India, vol. v., p. 92.

tends to set itself broadside on to the direction of motion; if then the bob be vertical and its broadest plane parallel to the plane of motion, it is always trying to rotate about its vertical axis, and in this way either the knife-edges will wabble on the suspension, or (if the pendulum be too heavy for that) a torsional stress is applied to the knife-edge, the direction of the stress being reversed twice in each oscillation: of course this stress is only small, but just as constant dropping wears away stones, so a constantly reversed stress wears out a knife-edge. The case is very different if the broadest plane of the bob be horizontal; here the only effect is a bending stress on the pendulum rod, a stress too small to produce any effect on a rod of ordinary dimensions. If we bear in mind that von Sterneck's rod is about $\frac{2}{5}$ of an inch thick, but that a decent steel knife-edge is not $\frac{1}{100,000}$ of an inch across, the advantage of transferring the stress from the knife-edge to the rod is at once evident.

Another point to be attended to is the position at which the starting lever gives its impulse to the rod. If this be not—as it generally is not—at or near the centre of oscillation, the operation of starting tends to produce a sideways shift of the head of the pendulum, and so to bend over and dull the knife-edge. Now to determine the dimensions of a pendulum of given form which shall have its centre of oscillation at a given point is a matter for calculation; the calculations are rather complicated, but quite manageable by known mathematical methods, so need not be detailed here.

(c) The supports of the pendulum must of course be as frictionless as possible. This is secured by attending to the construction of the knife-edges and planes of suspension; and here we have the advantage of the experience gained by the manufacturers of chemical balances, among whom the general consensus of opinion seems to be that a steel knife-edge and agate planes affords less friction than any other combination. Agate knife-edges cannot be given so fine an edge as steel, and the similarity of the material of planes and knife-edges is a further objection, and although there is of course no risk of rust, there is some danger of splitting the knife-edge; the advantage here is on the side of the steel, for a rusty steel knife-edge can be reground, but a split agate is of no further use and must be replaced by a new one.

(d) However carefully we construct our pendulums we shall always have to correct the observed vibration number for temperature and air pressure, and the corrections are by no means small. Temperature changes affect both the dimensions of the pendulum and the general properties of the medium in which it swings, while pressure affects only the second of these. We therefore require to determine both these quantities with considerable accuracy; for pressure this is easy enough, a good syphon barometer gauge being all that is wanted; but the determination of the temperature is not so simple, and observers are by no means agreed as to the best method of attaining it. The general assumption appears to be that a thermometer will follow the changes of temperature of the air more quickly than will the pendulum. Accordingly many observers, including Sabine and Mendenhall, sink the thermometer bulbs in a metal bar of the same thickness as the pendulum rod, while von Sterneck encloses the whole thermometer in a wide glass tube. The latter plan is almost certainly bad; for the heat has first to make its way through a glass tube, then across a layer of air, and then to heat up the thermometer. But is Sabine's plan very much better? If we consider the structure of a thermometer bulb, viz.: a thin layer of glass, which is notoriously a bad conductor of heat, and then a cylindrical mass of mercury about as thick as, and a worse conductor than, the pendulum rod, and if we bear in mind that convection currents probably play only a secondary part in equalising the temperature of different parts of the thermometer bulb, and further that all delicate thermometers are sluggish in their indications, I think we shall see that an unprotected thermometer with a tolerably large bulb, set as near as possible to the pendulum, will probably lag in temperature behind the air of the containing vessel by about the same amount as the pendulum itself, and in consequence the thermometer is more likely to give the actual temperature of the pendulum if arranged in this way than if sunk in a metal bar or otherwise modified. In any case delicate thermometers are required; they should register at least to one-twentieth of a degree Fahrenheit, preferably to one-fiftieth of a degree Centigrade.

(e) But little need be said as to the containing apparatus. It should certainly be of metal, in order as far as possible to secure

uniformity of temperature throughout the enclosure, and should be painted of a light colour externally, so as to diminish the rate of absorption of heat: it cannot very well be left bright, as the light reflected from it would be a serious obstacle to observing. The apparatus should of course be rigid and tolerably heavy, otherwise the pendulum when swinging will set it in vibration; it should also be a form of very stable equilibrium, else external disturbance may shake it and interefere with the motion of the pendulum. A truncated cone of thick brass seems to answer every purpose; glass windows can be introduced where necessary, and the case should be mounted on *large* levelling screws, which stand in metal grooves on a heavy support of stone or timber. Such an apparatus need not weigh more than half-a-hundred-weight or so all told, and need take up but little room; a striking contrast to the Indian apparatus, which is extremely bulky and weighs nearly a ton.

Appendix B.

Part of a Letter from Sir G. G. Stokes, Bart., P.R.S., *to the Secretary.*

7 Queen's Parade, Bath,
6th August, 1891.

Dear Mr. Love,

You do not say expressly, but I take for granted that in the contemplated gravity survey you mean to use invariable pendulums, not Kater's pendulum, or some other form available for absolute determinations. It is generally, I think, allowed that for determining the *variation* of gravity from place to place the results obtained by invariable pendulums are the more accurate. The series of determinations would be rendered absolute by transporting the pendulums to some station where gravity has been well determined absolutely and swinging them there. It will suffice if the station last mentioned be one for which gravity is accurately known absolutely by comparison, by means of invariable pendulums used by previous observers, with some other station where gravity had been determined absolutely.

At least two pendulums just like each other should be used, in order that any accidental derangement of a pendulum may be detected. Sabine said to me in conversation that there ought to be three, as that would enable you, in the event of any derangement taking place in course of transit or handling, to tell which pendulum it was that had got altered. If you had only two, and one got slightly deranged, you could only tell which it was by going back to one of the stations where they had been previously used and swinging them afresh. However, I think two only have as a rule been all that have been used in gravity surveys, and I believe that with care in packing, transporting, and handling, such derangements are not likely to occur.

Before fixing on the form we must answer the question, Is the correction for the resistance of the air going to be determined by calculation or by experiment?

(a) If by calculation, we are restricted to forms for which it is possible to effect the calculation. The pendulum might be a plain cylindrical rod, or such a rod with a sphere at the end. In an invariable pendulum, soundness of casting would not be of any very great moment, the observations being strictly differential. If a rod be used, I should prefer the ends being made hemispherical, or thereabouts. The exact form is of no particular consequence, for for a small portion of the rod near the end the calculation cannot be effected, whether the rod be left plain, or formed into a hemisphere. The calculation for a sphere would not apply to a hemisphere joined on to a cylinder. But the part of the resistance which depends on what is near the end of the rod forms only a small fraction of the whole, and if we are obliged to have recourse to estimation for that small portion, the uncertainity thence arising can be only very small, since the rod is supposed to be but narrow for its length. The alternative is to adopt the form mentioned by General Walker, a cylindrical rod with a sphere at the end. I do not think there is much to choose between these two forms. I think the latter would keep up its oscillations somewhat longer, and the former would have to be about five feet long (for a seconds' pendulum) which might perhaps be a little inconveniently long. I do not know however that this would be any serious inconvenience.

As to the calculation it is to be remarked that the numerical value of the index of friction given in my paper is much too low. This arises in great measure from my having corrected for the residual air in Baily's swings at reduced pressure (about one inch of mercury) on the supposition (which seemed to be conformable to the single experiment that Sabine had made on the subject) that the coefficient of viscosity, the μ of my paper, varies as the density. We know that Maxwell's law, according to which it is independent of the density, is very accurately true in experiment. The true coefficient is now well known for air. I have not got here books of reference, but towards the end of a paper of Tomlinson's in the Phil. Trans., in which he treats of the viscosity of air, you will find collected the numerical results of various observers, himself included. The effect of reducing, in my paper, by a law as to the relation between viscosity and density now known not to be the law of nature was to exaggerate the effect of reduction of pressure, in other words to under-estimate the effect of the residual air, and therefore, in equating the theoretical expression for the difference between thirty inches pressure and one inch in the observed result, to bring out a coefficient which was decidedly too small. The adoption however of the true law, though it raises considerably the coefficient of viscosity as got from Baily's experiments, leaves it still too small. I do not see how to account for this except on the supposition that the motion of the pendulums was not small enough to allow of a strict application of the formulas of my paper. I have remarked in my paper (at least with reference to a suspending wire, and the same would of course be true generally) that the effect of the formation of eddies would be to tend to throw the effect of the resistance from off the time on to the arc. Whether any sensible part of the resistance is due to the formation of eddies, may be tested by seeing whether the arc of vibration decreases strictly in geometric progression as the time increases in arithmetic. I examined in this way some of Sabine's experiments in the Phil. Trans., and some of Bessel's experiments with the long and short pendulums. Plotting a curve with the time and log-arc for co-odinates, it came a straight line for the long pendulum, but the curve, though very nearly a straight line for the shorter pendulums, had a sensible though slight curvature. It appears therefore that with

the amplitude of vibration usual in pendulum experiments, at least in the early portion of the swing the effect of eddies is not wholly insensible, and therefore it may well be that the formula in which the motion is assumed to be small enough to be regular may not be quite applicable to the actual experiments. However, beyond the discrepancy between the calculated and observed decrement of the arc of vibration, which I have mentioned in my paper, and also the decrement being not quite strictly in geometric progression, there was nothing to indicate that the formulas were in any way in fault, so very good seemed the agreement between theory and observation, until it was shown that the correction of the assumed law as to the relation between the viscosity and the density still left the numerical value of the index of friction as determined from the pendulum experiments slightly too small. But in merely differential observations, such as those carried on with invariable pendulums, I think any uncertainty of this kind would be quite insensible provided that care were taken that the observations should be strictly differential or very nearly so. Hence, if you wish to connect a group of Australian stations with Indian stations it is a perfectly open question whether you shall choose a pressure of say twenty-eight inches for the Australian set or a pressure of say four inches (or whatever the usual Indian pressure for India was). That is on the supposition, which I gather from your letter is intended, that you mean to construct new pendulums. The pendulums being different, the two series cannot be connected till the new pendulums are swung at one of the old stations, unless you are ready to trust to a reference of each series to an absolute determination belonging to it. But in either case if the higher pressure were thought the more convenient for the Australian stations, and it were not wished to trust to a correction for so great a difference of pressure as twenty-eight and four inches, it would merely be requisite to swing the invariable pendulums twice in succession at the reference station, once at the higher pressure, to connect with the Australian series, and once at a low pressure to connect with the Indian series or with the absolute determination as the case may be. If the vacuum apparatus be not quite staunch, as I fear may prove to be the case, it might be better, as a matter of

convenience and indeed accuracy, and as Colonel Herschel has proposed, to use the vacuum apparatus only for ensuring a constant pressure of say twenty-seven or twenty-eight inches, except of course for the one set of swings at low pressure taken at the station of reference. However, much would depend on the condition of the vacuum apparatus.

I will mention here lest I should forget it that it is well to allow an observation (whether by a single swing, as may be done in vacuo or by a succession of swings does not much matter) to extend over twenty-four hours, or if that be inconvenient at least from dark to dark, through day or night as may be chosen, so as to rate the clock by transits for the interval of time over which the observations extend. For you cannot trust a clock, even though the rate from day to day be very uniform, to be quite exempt from a diurnal inequality of rate.

(b) Suppose now that we prefer to depend on experiment for the correction for the air. Then we may choose our form of pendulum as we please. That usually employed has the bar somewhat thin, in a fore and aft direction, so as to be slightly flexible. Without this there is, I believe, some difficulty in ensuring that the weight shall bear well on *both* agate planes, so as not to run the risk of turning slightly about a vertical axis to and fro as it swings. I recollect someone (Sabine, I think), telling me that someone, I forget who, did not like the flexibility, and proposed to make the pendulum stiff, and Kater (I think it was) said, "He'll find it will not do."

The form having been chosen, we have to find the correction for the air experimentally. This demands the use of a vacuum apparatus. I think the most convenient plan would be to get a *fac-simile* of the pendulum made of wood. The resistance of the air depends only on the form and time of vibration of the pendulum, I mean supposing the state of the air given, and these would be the same for the actual pendulum and for the wooden model. By avoiding a specially dense wood we might easily get the model ten or twelve times as light as the actual pendulum, and the effect of the air on arc and time would be magnified ten or twelve times. The whole time of the swing would be reduced in the same proportion; but this would not signify as regards having a shorter interval by which to divide any error of observation of

the initial or final coincidence, for the method of coincidences is so exact that it may be deemed perfect; that it is to say any error from this would be swallowed up by much larger errors from other sources; and that being the case there is a great saving of time in using the model, besides which we are less exposed to errors from variations in the clock's rate, changes of temperature, etc. However the actual pendulum might of course be used, and probably in any case an observation or two would be taken with this for controul. And besides the saving of time in taking the observations, resulting from using a wooden model, the possibility of taking swings at different pressures in close proximity, merely allowing an interval sufficient to allow the disturbance of temperature consequent on the exhaustion or admission of air to subside, would I think be conducive to accuracy as securing a more near identity in the rate of the clock on the occasion of the two swings that are to be compared.

You mention the corrections for pressure and temperature. The latter depends partly on the expansion of the metal, partly on the effect of temperature in altering the state of the air, and therewith the correction on account of the air. I am not sure whether or not you meant to include the effect of the expansion of the metal.

If it is intended to keep the two parts separate, I suppose it is meant to calculate the part due to the metal from the linear expansion either ascertained by direct observation or assumed as known for the kind of metal employed. As to the air, the correction for buoyancy, and that portion of the correction for inertia which would form the whole if there were no viscosity, both one and the other vary as the density, and therefore in a known manner as regards the temperature. The rest of the correction for inertia depends in a more complicated manner on the temperature. The whole of this residue for a sphere, and the first term and most important part of it for a not too narrow cylindrical rod, varies as $\sqrt{\mu\rho}$. ρ of course varies inversely as $1+\alpha\theta$ (θ the temp. α the co-efft. of expansion) but μ increases as the temperature rises, according to what law does not appear to be known for certain. I think experiments on transpiration gave it about as $(1+\alpha\theta)^{0\cdot7}$, but I am away from books of reference, and I do not remember exactly.

If the temperature correction should be determined directly as a whole, *i.e.* effect on metal and on air together, by swinging the pendulum in air at two pretty widely separated temperatures, it is to be remembered that as it is made up of two different parts (effect on metal and effect on air) following different laws, the result will not be available unless some element (say the pressure) be kept constant. The experiment would involve the use of an apartment artificially heated in an equable manner,* unless we were content to wait all the time from one season to another, say summer to winter. The temperature correction so determined for a pressure of say 28 in. would not apply (on account of that part of it which depends on the air) to a pressure of say 3 in. It would seem to be best to correct as best may be for that part which is due to the air so as to get the part which is due to the expansion of the metal. I think the effect of the air can be got well by using a wooden model, and altering the observed effect in the ratio of Mh to $M'h'$, and M/M' can be got by weighing, and h/h' by balancing separately the model and actual pendulum on their edges.

I shall be happy to reply to further enquiries.

Yours very truly,

G. G. Stokes.

* P.S.—With a wooden model the effect of the air is so much larger, the time of swinging so much shorter, and the expansion of the material by heat so much smaller, that there would be little difficulty in rigging up an apartment which would serve quite well enough for that.

ART. XIX.—*A Description of a New Pendulum Apparatus, with Half-Seconds Pendulums.*

By R. L. J. ELLERY, C.M.G., F.R.S., F.R.A.S.

[Read 14th December, 1893.]

When the Kater's Invariable Pendulums, lent by the Royal Society of London for the Gravity Survey of Australia initiated by this Society, arrived and were installed at the Observatory, the cumbrous character of the whole apparatus convinced me that the cost of transport and of installation at the various observing stations would be a serious hindrance to the undertaking. When, therefore, some months later, an Austrian officer of the warship *Saida* brought a set of half-seconds pendulums, for making a series of gravity observations at the Observatory for connection with the Vienna base, I was struck with the immense convenience of transport and facility in making the necessary observations which these instruments afforded, and as I soon ascertained that the results appeared in every respect as good as with the larger pendulums, I determined to get a set made to test the question, hoping that they might be found efficient for the survey work. These pendulums and apparatus are now complete, and are on the table for the inspection of members. They are made after the plan adopted by Colonel von Sterneck of Vienna, but with certain modifications, and are in some respects similiar to the half-seconds pendulums recently used in the United States Coast and Geodetic Survey, and described by Mendenhall in his report for 1891.

The apparatus consists of three half-seconds pendulums, a coincidence or flash apparatus, a pendulum-stand, thermometers, air-pump, &c., as well as a break circuit chronometer.

In the design and construction of the pendulums, the chief and essential requirement of invariability and symmetry of form have had the first consideration. Great care was also taken as regards the metal of which they were first formed, to secure

solidity, evenness of texture and a good surface. The form is simple, and, with the exception of the cross-heads, are figures of revolution. It has been usual to have the knife-edge on which the pendulum oscillates on the pendulum itself, but it is almost impossible in that case to secure invariability of length, owing to gradual blunting of the knife-edges by wear; they are therefore made part of the stand, while the planes are on the pendulum cross-head; by this means, wearing of the knife-edges or sharpening them brings about no variation in the lengths of the pendulums.

Of the pendulums themselves, two are made from phosphor bronze, and one from ordinary gun-metal, and care was taken that the metal is solid and homogeneous throughout. In shape they are all alike, the "bob" or "weight" of the pendulum is in the form of two low truncated cones, base to base in one solid casting 98mms. diameter at base of cones, and 36mm. thick; the rod is truly cylindrical, 1cm. diameter, the length of pendulum over all 303mm., and from planes to bottom of bobs 235mms. The rod is fixed to the bob by being turned down at one end to a very long cone, which nearly fitted a hole in the bob of a similar conicity; the rod was then ground into the hole until it fitted nearly up to a small shoulder at the top of the conical part of the rod. The bob was now immersed in boiling water to expand it, when the rod was inserted and driven up to the shoulder; in cooling, the bob and rod became to all intents and purposes solidly connected. The lower end of the rod projected slightly through the bob, while the bottom of the hole through the bob was slightly countersunk; the projecting rod was here carefully rivetted, and the bottom of the bob then finished off.

The suspensions are agate planes attached to metal cross-heads, which are made to fit accurately and symetrically on the rods, great care being taken to secure as perfect rectangularity of the agate planes with the pendulum rod as possible. The suspension cross-heads consist of cubes of gun-metal truly bored to fit on the pendulum rods. The lower part of the cubes are widened out on two sides to give a bearing for the planes as well as to form two cylindrical arms, by which the pendulums are lifted and lowered on to the knife edges of the stand. On the two faces of the cube that are not widened out are fixed two small mirrors of parallel

glass, silvered at the back. The agate planes are fitted into a separate piece of gun-metal by means of a groove planed out on one face with V's at the sides; the agates are ground to a bevelled edge on two sides to fit into this groove, and are driven in tight in such a way as to be free from any strain that would crack or splinter them. The agate planes thus fitted are then ground and polished as one plane. The agates and their matrix of gun-metal fit precisely on planes at the bottoms of the cross-heads, and are secured by four small steel screws. Now, as it is absolutely necessary the agate planes should be accurately at right angles to the pendulum rods, they had to be carefully tested, for no matter how accurate may be the workmanship in fitting the cross-heads, some small errors are sure to remain. To do this I arranged a spectrometer with a piece of metal exactly the size of the pendulum rod, fixed horizontally, on which to place the cross-head and agates, then illuminating the slit of the collimator, read the angle of reflection from one of the planes in both horizontal and vertical direction with the telescope. The cross-head was then reversed 180° till the other plane came under the collimator, and the angles read again; any difference of angles was got rid of by lightly scraping the bottom surface of the cross-head on which the agate plate rested. By this means the agate planes were brought practically at right angles with the rods in both directions. Great care was also taken in securing the cross-heads to the rods. They fitted sufficiently tight to enable swings to be taken for ascertaining their times of vibration, and when this was satisfactory, a hole was bored through cube and rod and a conical steel pin driven firmly through both. The top of the rod and cross-head were then finished off together, and the pendulums were thus completed. Every part had been well smoothed and highly polished previously to the final fixing of the cross-head. The weights of the pendulums are approximately as follows:— No. I., 1814 grammes; No. II., 1787 grammes; No. III., 1811 grammes. Arrangements are made to avoid the necessity of handling or touching the pendulums, except with a leather-lined lifting handle and a leather strap, by which they can be lifted from their chamois-lined couches in the packing case, and placed on the lowering forks of the stand without touching any part with the fingers. To preserve their invariability, all touching

that might cause corrosion, oxidation, or usage likely to cause abrasion, has to be most carefully avoided.

There are two stands: one which is exhibited is the vacuum stand or receiver, in which the pendulums are swung in vacuo or at any atmospheric pressure below the normal; it is a hollow cone of gun-metal with a wide base, and formed with a flange at the top to receive the dome, which has a similar flange at the bottom. These flanges are ground together, and when greased with tallow form an air-tight joint. The inner part of the flange of the stand carries a strong moveable metal stage, accurately fitted on, which carries the knife-edges, lifting lever, a fixed mirror, and a thermometer. This stage is secured by two strong milled head screws, and can be readily removed for putting in or taking out the pendulums. The requisite attachments for exhausting the chamber, attaching a barometer or manometer, as well as a lever for giving the necessary impulse to the pendulums, are provided; the latter working through stuffing-boxes. The stand in use rests by three studs on a stout tripod with three levelling screws. The receiver and dome with the tripod weigh about fifty-two pounds.

The knife-edges, like the agates, are necessarily in two pieces, but they are practically in one by the mode of construction. A block of gun-metal 50mm. wide, 64mm. long, and 10mm. thick, to carry the knife-edges, is strongly screwed on to the platform of the stand, the opposing surfaces being ground together; the front of the block is 25mm. thick for 10mm. back, and this forms the matrix for the knife-edges; this front part of the block is divided by a recess to admit the pendulum rod, 20mm. wide, and 15mm. front to back. The knife-edges are made of the finest steel "glass hard." The mode of construction was as follows:—The steel prism, from which the knife-edges were eventually formed, was first fitted into a groove on the top of the block which was planed out to the proper form and the prism driven in as a "drift." The prism was then taken out, cut in two and hardened, then the grooves were slightly closed at the upper edges, and the pieces fixed finally in their place. The knife-edges were then ground, sharpened and polished as one piece by means of a special tool. This is a square base of cast-iron in which the gun-metal block carrying the knife-edges can be fixed precisely at right

angles to a double pair of V grooves in the base, on which a block of cast-iron carrying a grinding cylinder and running parallel to the knife-edges can be traversed as in a planing machine. The cylinder receives rapid rotation from any outside motor, while the grooved block is traversed to and fro in its grooves by hand. A means of approaching the knife-edge block towards the grinder is supplied by a fine pushing screw.

To obtain accurate horizontality of the knife-edges, a delicate level resting on agate planes similar to the pendulum cross-heads, with a light rod and bob below, forming a small pendulum, is used, and is lowered on the knife-edges exactly as the pendulums themselves are.

A second stand of cast-iron is used when swings are made at ordinary atmospheric pressures. This is formed of two A-shaped uprights joined at the top by a rectangular platform, and a heavy circular base, resting on three rounded feet. On the platform, 100mm. square, is the platform carrying the knife-edges and other arrangements as described already ; but in this case the final levelling of the knife-edge is done by levelling the platform on the stand by special levelling screws.

The coincidence apparatus consists of a stand with levelling screws carrying a rectangular metallic box, within which are an electro-magnet, armature and lever, a mirror, and a mechanical shutter. Horizontally over the metal box is mounted a telescope with a horizontal wire at its focus. In front of the box is a narrow horizontal slit, about an inch and a half below the object-glass of the telescope, and on one side of the box a circular opening admits light from a lamp, candle, or other source on to the mirror within the box, whence it is reflected on to the slit in front ; the shutter, however, occults the slits except at the instant the electro-magnet acts on the lever, when an instantaneous flash is projected through the slit. A flash would occur both at the rising and return of the lever but for the shutter (a modification of an ingenious arrangement described by Mendenhall, report cited above) which keeps the slit occulted for either the up or down stroke of the lever, as may be desired. There is a black and white scale, divided to three millimetres spaces in front of the box, with an opening for the slit above-mentioned in its centre.

The mode of observing is as follows:—The stand being placed on a solid pier of stone, brick-work, or other material, and properly levelled, it is so placed that when a pendulum is placed in it, one of the mirrors shall face the observer, who sits down from five to seven feet away, with a good steady table or tripod stand in front of him to support the coincidence apparatus, the candle or lamp for illuminating the slit, a break circuit chronometer, a telegraph key or commutator, and a portable galvanic cell. He then arranges the apparatus so that he can read his millimetre scale in front of the box as it is reflected by the mirror on the pendulum. He now connects up his coincidence apparatus with his clock or chronometer, when the electro-magnet lifts the shutter every second, and an instantaneous flash is seen by means of the telescope reflected from the mirror. He next sets the pendulum swinging through a very small arc by means of the impulse lever, when the images of the scale and slit, as seen reflected from the pendulum mirror, oscillate in a vertical direction over a distance magnified by both the telescope and the distance of the mirror from the telescope. The fixed mirror on the stand reflects a stationary image of the flash at each occurrence, while the reflection from the pendulum mirror occurs successively at all parts of the vertical arc over which it oscillates. The moment of coincidence is when the latter appears in a horizontal line with the flash reflected by the fixed mirror. The time elapsed between coincidences in the same direction of the pendulum's motion is the "coincidence period," the mean value of which in twenty-four hours is what is sought, so as to obtain the true number of vibrations made in a solar day by the several pendulums of the set, from which a mean value is deduced.

In a brief description it is undesirable to describe in detail the various adjustments and corrections, which are numerous; but what I have given here will afford some idea of the new set of half-seconds pendulums and the method of using them.

ART. XX.—*The New Chain Test Range at the Melbourne Observatory.*

By R. L. J. ELLERY, C.M.G., F.R.S., F.R.A.S.

[Read 14th December, 1893.]

The old chain test range laid down in the Observatory grounds in March, 1871, was found in January, 1892, to have a small increasing error, and being only six inches above the ground surface, was found inconvenient to use. It was formed by five cubical blocks of sandstone, set on brick and cement foundations, one at either end of the 100 feet range, others at 50 feet, 33 feet, and 66 feet. Gun-metal plates fixed to the stones carried the fiducial marks. In March, 1893, a new range was erected, consisting of four heavy brick and cement piers, 2ft. 5in. high, 2ft. long, by 18in. wide, capped with blocks of rubbed "bluestone." A platform from pier to pier was built of stout deal planks, T-shaped, supported on 6in. by 6in. red-gum posts firmly fixed in the ground. The height of this platform and surface of cap-stones is about 2ft. 5in., and very convenient for measuring and comparing. The fiducial marks are on gun-metal blocks, fastened to the stone caps at 0ft., 50ft., 66ft., and 100ft. On the 66ft. pier are two marks 12in. apart; one is 16ft. from the 50ft., and the second 33ft. from the 100ft., so as to obtain a standard foot and a half-chain measure. At the terminal piers wooden pillars are fixed to hold the adjusting screws and tension springs for stretching chains and tapes, and the fiducial marks are arranged to measure from end handles ("bût a bût") or marks ("traits"). Tension can be given to any chain, tape, or other measure at any intermediate point by means of a shifting toggle, to which the tension screws can be attached. The measures of this range were made with the 10ft. steel bars used for the Victorian base line, the measurement being made in the same manner—that is, bars placed end to end, but about one-fourth of an inch apart, aligned and levelled, the space being measured

by a graduated wedge of bell-metal. The lengths are found to be as follows (reduced to a temperature of 62° Fahr): 0 to 100 = 1199·9749 inches, 0 to 50 = 599·9647, 50 to 100 = 600·0103.

The old range measured at 66 and 100, when first put up, 792·18 inches and 1200·20 inches; but just before removal the measure was 792·22 and 1200·32.

The stability of such ranges is found to be extremely good, but not absolutely perfect, for a secular change in the old range of 0·12 inches took place. This, however, is of no moment, as no standard measures are absolutely correct or perfectly permanent; the only point necessary is that the value of the standard should be obtained from time to time, and persons using the test should always obtain the value from the latest measures.

For very accurate comparisons and for determining expansions in high temperatures, a heavy iron block, with reading microscope, has been made, by which variations of $\frac{1}{1000}$ are easily measured.

MEETINGS OF THE ROYAL SOCIETY,

1893.

ANNUAL MEETING.

Thursday, 9th March.

The President (Professor KERNOT) in the chair.

On the motion of Mr. RUSDEN, seconded by Mr. HOGG, the following Annual Report and Balance Sheet were taken as read and adopted :—

ANNUAL REPORT OF THE COUNCIL FOR THE YEAR 1892.

The Council of the Royal Society herewith presents to the Members of the Royal Society the Annual Report and Balance Sheet for the year 1892.

The following Meetings were held, and Papers read during the Session :

March 5.—"Preliminary notice of Victorian Earth-worms. Part II. The Genus Perichæta," by Professor W. Baldwin Spencer, M.A.

May 12.—"On Confocal Quadrics of Moments of Inertia, pertaining to all Planes in Space; and Loci and Envelopes of Straight Lines whose Moments of Inertia are of constant magnitude," by Martin Gardiner, C.E. "Further Notes on the Oviparity of the larger Victorian Peripatus, generally known as *P. leuckartii*," by Arthur Dendy, D.Sc. "The Responsibility of Criminals," by Alex. Sutherland, M.A.

June 9.—"On the Nest and Eggs of the Victoria Rifle Bird (Ptilorhis victoriæ)," by D. Le Souëf. "The Blood Vessels of Ceratodus forsteri," by Professor W. Baldwin Spencer. Adjourned discussion on "The Responsibility of Criminals," Colonel J. R. Y. Goldstein.

July 14.—"Notes on the Lilydale Limestone," by Rev. A. W. Cresswell. "Preliminary Note on the Glacial Deposits of Bacchus Marsh," by C. G. W. Officer, B.Sc., and L. J. Balfour. The Report of the Cremation Committee brought up by the Honorary Secretary, and exhibition by F. Chamberlain, Esq., of a

model to explain the working of the Govini Incinerator, in use at Woking, Surrey, England.

August 11.—Adjourned discussion on Preliminary Note on the "Glacial Deposits of Bacchus Marsh," by C. G. W. Officer, B.Sc., and L. J. Balfour. "The Conductivity of Copper Sulphate Solutions," by W. H. Steele, M.A. (communicated by Professor Lyle).

September 8.—"Snake-bite," by J. W. Barrett, M.D. "Notes on the Structure of the Poison Fang in certain Australian Snakes," by Professor W. Baldwin Spencer. "Three Rare Species of Eggs, hitherto only described from the Oviduct of the Bird," by A. J. Campbell, F.L.S. (communicated by Professor Spencer). "Synopsis of the Australian Calcarea Heterocœla, with a proposed classification of the group, and descriptions of some new Genera and Species," by Arthur Dendy, D.Sc.

October 13.—"On two new Tertiary Stylasterids," by T. S. Hall, M.A. "Notes on the method of Reproduction of *Geonemertes australiensis*," by A. Dendy, D.Sc. Exhibition by Mr. E. F. J. Love, M.A., of Professor Rowland's Photographs of the Solar Spectrum.

November 10.—"Physical Constants of Thallium," by W. H. Steele, M.A. "Notes on a Poisonous Species of *Homeria*, found at Pascoe Vale, causing the death of cattle and other animals feeding upon it," by D. McAlpine and P. W. Farmer, M.B., Ch.B. "The Lichenology of Victoria, Part I," by Rev. F. R. M. Wilson (presented by W. H. Archer, F.L.S).

December 8.—"Sneezing—Fallacious Observations," by J. W. Barrett, M.D. "Description of a New Victorian Species of Leucosolenia," by A. Dendy, D.Sc.

During the course of the year four Ordinary Members, one Country Member, and eight Associates have been elected; whilst eighteen Members and Associates have resigned.

Your Council recommended the election of Professor Liversidge, F.R.S., as Honorary Member, in recognition especially of his valuable services in connection with the formation of the Australasian Association for the Advancement of Science. Professor Liversidge was unanimously elected an Honorary Member at the Ordinary Meeting of the Society held in December.

Your Council regrets to report the resignation as member of the Council, of Mr. A. H. S. Lucas, who has left the colony to take up the position of Head Master of the Newington College, Sydney.

The Librarian reports as follows:—

"During the past year the Library has been growing rapidly, 954 books or parts having been received. Considerable progress has also been made with the revision and cataloguing of the Library, manuscript catalogue slips having been written out for the majority of the books. The Binding of the books has been continued so far as funds have permitted, 164 volumes having been bound.

"Owing to the great increase in the number of books in the Library, more shelving is very urgently required. As soon as this is ready it is proposed to re-arrange the books according to subjects, instead of, as at present, according to nationality.

"A very large number of valuable Serials still remain unbound, in which condition they cannot be used without great inconvenience to the student, and risk of much injury to the books themselves. It is impossible to place the Library in thorough working order without incurring considerable expense, but when this has once been done there should be no further difficulty in keeping it up. The Library is now a very valuable and comprehensive one, and steps should be taken to render it available to Members and Associates of the Society. When once placed in thorough order and with a catalogue up to date, it ought to prove a great inducement to scientific gentlemen to join the Society."

During the course of the year the following publications have been issued:—"Proceedings," Vol. IV. (New Series) Part I., "Proceedings," Vol. IV. (New Series) Part II., and "Transactions," Vol. II., Part II.

The Society has suffered financially in consequence of the prevailing depression. In addition to the loss of subscriptions, the Government Vote has been reduced from £500 to £250 per annum. In consequence of this, it has been decided to discontinue, for the present, the issue of the "Transactions," and to limit the publications of the Society to "Proceedings." This is much to be regretted, inasmuch as the Council finds itself unable to publish the results of various researches carried on by its Members, and having especial reference to the Australian Colonies. It is hoped that, with the return of prosperous times, the issue of the "Transactions" may be soon continued.

The Honorary Treasurer in Account with the Royal Society of Victoria.

Dr.			Cr.	
To Balance from 26th February, 1892 ...		£216 2 3	By Printing and Stationery	£293 6 9
,, Government Grant—			,, Rates...	4 2 6
Balance of Vote 1891-92	£250 0 0		,, Gas and Fuel	6 12 9
Instalments for 1892-93	110 0 0		,, Salary, &c., of Assistant-Secretary ...	88 3 6
		360 0 0	,, Shorthand Records	10 15 6
,, Entrance Fees		9 9 0	,, Hall-keeper's Allowance	5 10 0
,, Subscriptions—			,, Collector's Commission	23 19 4
Members	110 5 0		,, Insurance	4 0 0
Country Members ...	23 2 0		,, Postages and Telegrams	25 13 8
Associates...	31 10 0		,, Repairs and Furnishing	2 12 6
Arrears	22 1 0		,, Books and Periodicals	11 5 0
		186 18 0	,, Freight	18 10 2
,, Rent of Rooms		21 5 0	,, Refreshments	6 4 8
,, Sale of Transactions		0 14 6	,, Binding	29 14 9
,, Interest		17 10 0	,, Incidentals	8 3 5
			,, Interest	0 6 5
			,, Balance (28th February, 1893)	272 17 10
		£811 18 9		£811 18 9

PUBLISHING AND RESEARCH FUND.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Fixed Deposit in Bank	£300	0	0	By Fixed Deposit in Bank of Australasia ...	£300	0	0
„ Interest on same	15	0	0	„ Interest transferred to General Account	15	0	0
	£315	0	0		£315	0	0

Compared with the Vouchers and Bank Pass-book and Cash-book, and found correct,

C. R. BLACKETT,
Hon. Treasurer.

R. E. JOSEPH,
H. MOORS, } *Auditors.*

28th February, 1893.

On the motion of Mr. Love, seconded by Mr. Howitt, the following gentlemen were elected as Office-Bearers and Members of Council:—President: Professor W. C. Kernot, M.A., C.E. Vice-Presidents: E. J. White, Esq., F.R.A.S., H. K. Rusden, Esq., F.R.G.S. Hon. Treasurer: C. R. Blackett, Esq., F.C.S. Hon. Librarian: E. F. J. Love, Esq., M.A. Hon. Secretaries: Professor W. Baldwin Spencer, M.A., and Dr. Arthur Dendy, F.L.S. Members of Council: W. H. Archer, Esq., Dr. J. W. Barrett, J. Dennant, Esq., F.G.S., Dr. J. Jamieson, H. R. Hogg, Esq., Professor T. R. Lyle, M.A., F. A. Campbell, Esq., C.E. The non-retiring members of Council were R. L. J. Ellery, Esq., C.M.G., F.R.S., G. S. Griffiths, Esq., F.R.G.S., Professor Orme Masson, M.A., H. Moors, Esq., Rev. E. H. Sugden, B.A., B.Sc.

The meeting then resolved itself into an Ordinary Meeting.

The minutes of the previous meeting were read and confirmed.

The Librarian's Report showed that 286 volumes and parts of volumes had been received since the last meeting.

Mr. L. J. Balfour and the Rev. Walter Fielder signed the Roll and were introduced to the meeting.

The Rev. F. R. M. Wilson and Mr. P. W. Farmer, M.B., Ch.B., were elected members of the Society.

The Rev. John Mathew read a paper entitled "Linguistic Points of Contact between the Aborigines of Australia and those of New Guinea." A discussion followed, in which the Rev. Lorimer Fison, Mr. Howitt and Dr. Dendy took part, and Mr. Mathew replied.

Mr. G. B. Pritchard read a paper by T. S. Hall, Esq., M.A., and himself, entitled "Notes on the Eocene Strata of the Bellarine Peninsula, with brief references to other deposits." A discussion followed, in which Mr. Griffths and Mr. Stirling took part and Mr. Pritchard replied.

The remaining papers were postponed till the next meeting.

Thursday, 13th April.

Mr. E. J. White occupied the chair.

The minutes of the last meeting were read and confirmed.

Mr. D. Avery, B.Sc., and Miss L. J. Little, B.Sc., were nominated as Associates.

The LIBRARIAN reported that 74 publications had been received since the last meeting.

Mr. C. FROST, F.L.S., read a paper by Mr. A. H. S. Lucas, M.A., B.Sc., and himself, entitled "The Lizards indigenous to Victoria." A discussion followed in which Mr. LOVE, Mr. WHITE and Dr. DENDY took part.

The SECRETARY read a paper by Mr. W. M. BALE, F.R.M.S., entitled "Further Notes on Australian Hydroids, with descriptions of some New Species."

Dr. DENDY read a paper entitled "Note on the Hatching of a Peripatus Egg." A discussion followed, in which Messrs. FROST, HOGG, LOVE and GRIFFITHS took part.

Mr. W. H. STEELE read a paper entitled "A new Thermo-electric Phenomenon." A discussion followed, in which Messrs. LOVE, BARNARD, BOOTH, WHITE, HOGG and DENDY took part.

A Collection of Victorian Lizards was exhibited by Mr. FROST during the evening.

Thursday, 11th May.

The President (Professor KERNOT) occupied the chair.

The minutes of the previous meeting were read and confirmed.

Mr. D. Avery, B.Sc., and Miss L. J. Little, B.Sc., were elected as Associates.

Mr. J. J. Eastick and Dr. T. Cherry were nominated as Members.

The SECRETARY read a letter from the Secretary of the Field Naturalists' Club, stating that a Committee had been appointed by that Society to endeavour to induce the Government to refrain from revoking the reservation of the Dandenong and Woori-Yalloak State Forest, and inviting the co-operation of the Royal Society. At the request of the Secretary of the Club Mr. GREGORY was permitted to address the meeting on the subject. A discussion followed in which Messrs. ELLERY, LOVE, GRIFFITHS, HOGG, WHITE and the PRESIDENT took part, and on the motion of Mr. Ellery, seconded by Mr. Love, a Committee was appointed, consisting of Messrs. White and Griffiths, to co-operate with the Committee of the Field Naturalists' Club in the manner indicated.

The Librarian's report showed that 92 publications had been received since the last meeting.

The Rev. LORIMER FISON, M.A., read a paper entitled "Notes on the Saibai, Kaurarega and Gudang Languages, with remarks on unsound philological methods." A discussion followed, in which the PRESIDENT, Mr. HOWITT and Dr. DENDY took part.

The remaining paper was postponed till the next meeting.

Thursday, 8th June.

The President (Professor KERNOT) occupied the chair.

The minutes of the previous meeting were read and confirmed.

Miss L. J. Little, B.Sc., an Associate, signed the roll and was introduced to the meeting.

Mr. J. J. Eastick and Dr. T. Cherry were elected members.

The Rev. H. W. Westmoreland was nominated as a Country Member.

The PRESIDENT read a letter from Mr. White, stating that he had attended the deputation to the Hon. the Minister of Lands, concerning the undesirability of alienating the Dandenong and Woori-Yalloak State Forests, but with no good results.

The LIBRARIAN reported that since the last meeting 54 publications had been received.

Mr. E. J. DUNN read a paper entitled "Glaciation of the Western Highlands, Tasmania." A discussion followed, in which the PRESIDENT, Mr. DENNANT, Mr. OFFICER, Mr. HOWITT, Mr. SWEET, Mr. PRITCHARD and Dr. DENDY took part, and Mr. DUNN replied.

Mr. G. C. W. OFFICER read a paper by himself and Mr. L. J. Balfour, entitled "Further Note on the Glacial Deposits of Bacchus Marsh." A discussion followed, in which Mr. DUNN, Mr. SWEET, Mr. DENNANT, Mr. PRITCHARD, Mr. LOVE, Dr. DENDY and Mr. BALFOUR took part, and Mr. OFFICER replied.

The remaining papers were postponed till the next meeting.

Thursday, 13th July.

The President (Professor Kernot) occupied the chair.

The minutes of the previous meeting were read and confirmed.

Dr. T. Cherry, a Member, and Mr. D. Avery, B.Sc., an Associate, signed the Roll and were introduced to the meeting.

The Rev. H. W. Westmoreland was elected a Country Member.

Mr. E. J. Dunn was nominated as a Member.

The LIBRARIAN reported that 107 publications had been received since the last meeting.

The SECRETARY read a paper entitled "Notes on the Trawling Expedition off the Lakes Entrance," by Mr. T. S. Hart, who had been appointed by the Council to represent the Society on the Expedition.

The Rev. JOHN MATHEW read a paper entitled "Defence of the Position—that there are Linguistic Points of Contact between the Aborigines of Australia and those of New Guinea, and Corroboration of the Theory that the Australian Aborigines entered the Continent on the New Guinea side." A discussion followed, in which the Rev. LORIMER FISON, Mr. HOWITT and Mr. ISAAC TIPPING took part, and Mr. MATHEW replied.

Dr. BARRETT read a paper entitled "Some Statistics showing the Extent of the Damage done to Members of the Medical Profession by the Abuse of Alcohol." A discussion followed, in which Professor KERNOT, Mr. ISSAC TIPPING, Dr. DENDY, Mr. MATHEW, Mr. WHITE and Dr. BARRETT took part.

The remaining paper was postponed till the next meeting.

Thursday, 14*th September.*

The President (Professor KERNOT) occupied the chair.

The minutes of the previous meeting were read and confirmed.

Mr. E. J. Dunn was elected as a Member.

Mr. Elliott Cairns, a visitor, was introduced to the meeting by the President.

The LIBRARIAN reported that 249 publications had been received since the last meeting (two months).

The SECRETARY read a paper by Mr. R. Etheridge, Junr., Corresponding Member, entitled "An Operculum from the Lilydale Limestone."

The Rev. A. W. CRESSWELL read a paper entitled "Additional Notes on the Lilydale Limestone." A discussion followed, in which Mr. CRESSWELL, Dr. DENDY, Mr. MCALPINE, Mr. ELLERY, Mr. PRITCHARD and the the PRESIDENT took part.

Mr. ELLIOTT CAIRNS exhibited a number of Mineralogical specimens from the Mount Wills district and made some remarks upon the occurrence of Gold in Granite in that locality. A discussion followed, in which Mr. DENNANT, Mr. PRITCHARD, Dr. DENDY, Mr. MCALPINE, Mr. CRESSWELL and the PRESIDENT took part, and Mr. CAIRNS replied.

Dr. DENDY read a paper entitled "Note from the Biological Laboratory of the Melbourne University:—On a Crayfish with abnormally developed Appendages."

Mr. LOVE made some remarks on the forthcoming meeting of the Australasian Association for the Advancement of Science, to be held at Adelaide.

Thursday, 12th October.

The President (Professor KERNOT) occupied the chair.

The minutes of the previous meeting were read and confirmed.

The LIBRARIAN reported that 91 publications had been received since the last meeting.

Mr. G. S. GRIFFITHS moved the following resolution: "That the Royal Society co-operate with the Royal Geographical Society in urging the Government to adopt and legalise the Hour-Zone system of time-reckoning." Mr. R. L. J. ELLERY seconded the resolution, which was discussed by Mr. WHITE, Mr. HAIG, Mr. STEELE, Mr. COANE, Mr. LOVE and the PRESIDENT. The resolution was put to the meeting and carried.

The following resolution was moved by Mr. R. L. J. ELLERY and seconded by Mr. G. S. GRIFFITHS—"That the Secretary inform the Secretary of the Royal Geographical Society of the resolution *in re* Hour-Zones, and state the readiness of the Royal Society to jointly sign any memorial to the Government which it may be decided to forward." The resolution was put to the meeting and carried.

Mr. PIETRO BARACCHI read a paper entitled "Results of Observations with the Kater's Invariable Pendulums, made at

the Melbourne Observatory—June to September, 1893." A discussion followed in which Mr. ELLERY, MR. LOVE, MR. WHITE, Mr. STEELE and the PRESIDENT took part, and Mr. BARACCHI replied.

The remaining paper was postponed till the next meeting.

Thursday, 16th November.

The President (Professor KERNOT) occupied the chair.

The minutes of the previous meeting were read and confirmed.

The LIBRARIAN reported that 82 publications had been received since the last meeting.

The SECRETARY read the report of the Antarctic Exploration Committee, forwarded by Mr. G. S. Griffiths.* The Report was received and the Committee was re-appointed with the following members :—Professor Kernot, Mr. G. S. Griffiths, Mr. R. L. J. Ellery, and Mr. H. K. Rusden.

In the absence of a formal report Dr. DENDY made some remarks on the works of the Port Phillip Biological Survey Committee; and the Committee was re-appointed with the following members :—Professor Spencer, Rev. A. W. Cresswell, Mr. W. M. Bale, Dr. McGillivray and Mr. J. Bracebridge Wilson.

Mr. BLACKETT read the Report of the House Committee. The Report was received and the Committee was re-appointed with the following members :—Professor Kernot, Professor Masson, Mr. H. K. Rusden and Mr. C. R. Blackett.

Mr. LOVE read the Report of the Gravity Survey Committee, with an Appendix.† The Report was received and the Committee was re-appointed with the following members :—Professor Lyle, Professor Masson, Mr. R. L. J. Ellery, Mr. E. J. White, Mr. E. F. J. Love and Mr. Pietro Baracchi.

Mr. ELLERY and the SECRETARY made some remarks on the work of the Printing Committee, and the Committee was re-appointed, with the Secretary and Treasurer for the time being and Mr. R. L. J. Ellery as members.

Dr. DENDY read a paper entitled "Observations on some new or little-known Land Planarians from Tasmania and South

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* *Vide* p. 211. † *Vide*, p. 213.

Australia." A discussion followed, in which Mr. Hogg, Mr. Blackett, Mr. Love, Miss Little, the President and Dr. Dendy took part.

Mr. Isaac Tipping read a paper entitled "Land Irrigation: Principles governing its Economic Application in Warm Climates." A discussion followed, in which Mr. Ellery, the President and Mr. Derry (a visitor) took part, and Mr. Tipping replied.

Thursday, 14th December.

The President (Professor Kernot) occupied the chair.

The minutes of the previous meeting were read and confirmed.

Mr. A. G. Fryett was nominated as a member.

The President gave notice that nominations of Officers and Members of Council would be required in time for election at the Annual Meeting in March.

Messrs. Moors and Joseph were re-elected as Auditors for the ensuing year.

A photograph of the Grave of Burke was exhibited, which had been presented to the Society by Mr. A. J. Skene, M.A. A vote of thanks to Mr. Skene for his interesting present was passed.

The Librarian reported that 119 publications had been received since the last meeting.

Mr. R. L. J. Ellery read a paper entitled "Description of New Half-Seconds Pendulum Apparatus for Gravity Observations." The apparatus referred to was exhibited, and a discussion took place, in which Messrs. White, Love and the President took part, and Mr. Ellery replied.

Mr. R. L. J. Ellery also read a paper entitled "Description of a new Chain Test Range at the Melbourne Observatory." A discussion followed, in which Messrs. White, Dendy, Fowler, Love, Steele, the President and Mr. Ellery took part.

Mr. C. R. Blackett read a paper by Mr. W. Percy Wilkinson, entitled "Preliminary Survey of the Eucalyptus-Oils of Victoria." The discussion on this paper was postponed.

Owing to the lateness of the hour, and the fact of its being the last meeting of the year, Mr. R. Etheridge's paper entitled "The Largest Australian Trilobite hitherto discovered," was taken as read. A few remarks on the subject matter of the paper being made by Mr. Sweet, Mr. Pritchard and Dr. Dendy.

LAWS.

Amended to December, 1892.

I. The Society shall be called "The Royal Society of Victoria." Name.

II. The Royal Society of Victoria is founded for the advancement of science, literature and art, with especial reference to the development of the resources of the country. Objects.

III. The Society shall consist of Ordinary Members residing within ten miles of Melbourne; Country Members residing beyond that distance; Life Members (Law XXV.), Honorary Members (Law XXIV.), Corresponding Members (Law LII.), and Associates (Laws XXV., XXVI., and LIII.), all of whom shall be elected by ballot. Members and Associates.

IV. His Excellency the Governor of Victoria, for the time being, shall be invited to accept the office of Patron of the Society. Patron.

V. There shall be a President, and Two Vice-Presidents, who, with twelve other Members, and the following Honorary Officers, viz., Treasurer, Librarian, and Two Secretaries of the Society, shall constitute the Council. Officers.

VI. The Council shall have the management of the affairs of the Society. Management.

VII. The Ordinary Meetings of the Society shall be held once in every month during the Session, from March to December inclusive, on days fixed and subject to alteration by the Council with due notice. Ordinary Meetings.

VIII. In the second week in March, there shall be an Annual General Meeting, to receive the report of the Council, and elect the Officers of the Society for the ensuing year. Annual General Meetings.

Retirement of Officers.

IX. All Office-bearers and Members of Council except the six junior or last elected Members, shall retire from office at the Annual General Meeting in March. Should a senior Member's seat become vacant in the course of the year, it shall be held by his successor (under Law XIII.), as a senior Member, who shall retire at the next Annual General Meeting. The names of such Retiring Officers are to be announced at the Ordinary Meeting in December. The Officers and Members of Council so retiring shall be eligible for the same or any other office then vacant.

Election of Officers.

X. The President, Vice-Presidents, Treasurer, Secretaries, and Librarian shall be separately elected by ballot (should such be demanded), in the above-named order, and the six vacancies in the Council shall then be filled up together by ballot at the General Meeting in March. Those members only shall be eligible for any office who have been proposed and seconded at the Ordinary Meeting in December, or by letter addressed to one of the Secretaries, and received by him before the 1st March, to be laid before the Council Meeting next before the Annual Meeting in March. The nomination to any one office shall be held a nomination to any office, the election to which is to be subsequently held. No ballot shall take place at any meeting unless ten members be present.

Votes required.

Members in arrear.

XI. No member, whose subscription is in arrear, shall take part in the election of Officers or other business of the meeting.

Address by the President.

XII. An address shall be delivered by the President of the Society at either a Dinner, Conversazione, or extra meeting of the Society, as the Council may determine in each year.

Vacancies.

XIII. If any vacancy occur among the Officers, notice thereof shall be inserted in the summons for the next meeting of the Society, and the vacancy shall be then filled up by ballot.

Duties of President.

XIV. The President shall take the chair at all meetings of the Society and of the Council, and shall regulate and

keep order in all their proceedings ; he shall state questions and propositions to the meeting, and report the result of ballots, and carry into effect the regulations of the Society. In the absence of the President, the chair shall be taken by one of the Vice-Presidents, Treasurer, or Ordinary Member of Council, in order of seniority.

Duties of Treasurer.

XV. The Treasurer may, immediately after his election, appoint a Collector (to act during pleasure), subject to the approval of the Council at its next meeting. The duty of the Collector shall be to issue the Treasurer's notices, and collect subscriptions. The Treasurer shall receive all moneys paid to the Society, and shall deposit the same before the end of each month in the bank approved by the Council, to the credit of an account opened in the name of the Royal Society of Victoria. The Treasurer shall make all payments ordered by the Council on receiving a written authority from the chairman of the meeting. All cheques shall be signed by himself, and countersigned by one of the Secretaries. No payments shall be made except by cheque, and on the authority of the Council. He shall keep a detailed account of all receipts and expenditure, present a report of the same at each Council meeting, and prepare a balance-sheet to be laid before the Council, and included in its Annual Report. He shall also produce his books whenever called upon to do so by the Council.

Duties of Secretaries.

XVI. The Secretaries shall share their duties as they may find most convenient. One or other of them shall conduct the correspondence of the Society and of the Council, attend all meetings of the Society and of the Council, take minutes of their proceedings, and enter them in the proper books. He shall inscribe the names and addresses of all Members and Associates in a book to be kept for that purpose, from which no name shall be erased except by order of the Council. He shall issue notices of all meetings of the Society and of the Council, and shall have the custody of all papers of the Society, and, under the direction of the Council, superintend the printing of the Transactions of the Society.

Retirement of Officers.

IX. All Office-bearers and Members of Council except the six junior or last elected Members, shall retire from office at the Annual General Meeting in March. Should a senior Member's seat become vacant in the course of the year, it shall be held by his successor (under Law XIII.), as a senior Member, who shall retire at the next Annual General Meeting. The names of such Retiring Officers are to be announced at the Ordinary Meeting in December. The Officers and Members of Council so retiring shall be eligible for the same or any other office then vacant.

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Votes required.

No ballot shall take place at any meeting unless ten members be present.

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Duties of Secretaries.

Meetings of Council.

XVII. The Council shall meet on any day within one week before every Ordinary Meeting of the Society. Notice of such meeting shall be sent to every member at least two days previously. No business shall be transacted at any meeting of the Council unless five members be present. Any Member of Council absenting himself from three consecutive meetings of Council, without satisfactory explanation in writing, shall be considered to have vacated his office, and the election of a member to fill his place shall be proceeded with at the next Ordinary Meeting of Members, in accordance with Law XIII.

Quorum.

Special Meetings of Council.

XVIII. One of the Secretaries shall call a Special Meeting of Council on the authority of the President or of three Members of the Council. The notice of such meeting shall specify the object for which it is called, and no other business shall be entertained.

Special General Meetings.

XIX. The Council shall call a Special Meeting of the Society, on receiving a requisition in writing signed by twenty-four Members of the Society, specifying the purpose for which the meeting is required, or upon a resolution of its own. No other business shall be entertained at such meeting. Notice of such meeting, and the purpose for which it is summoned, shall be sent to every Member at least ten days before the meeting.

Annual Report.

XX. The Council shall annually prepare a Report of the Proceedings of the Society during the past year, embodying the Balance Sheet, duly audited by two Auditors, to be appointed for the year at the Ordinary Meeting in December, exhibiting a statement of the present position of the Society. This Report shall be laid before the Society at the Annual Meeting in March. No paper shall be read at that meeting.

Auditors.

Expulsion of Members.

XXI. If it shall come to the knowledge of the Council that the conduct of an Officer, a Member, or an Associate is injurious to the interest of the Society, and if two-thirds of the Council present shall be satisfied, after opportunity of defence has been afforded to him, that such is the case,

it may call upon him to resign, and shall have the power to expel him from the Society, or remove him from any office therein at its discretion. In every case, all proceedings shall be entered upon the minutes.

Election of Members and Associates.

XXII. Every candidate for election as Member or as Associate shall be proposed and seconded by Members of the Society. The name, the address, and the occupation of every candidate, with the names of his proposer and of his seconder, shall be communicated in writing to one of the Secretaries, and shall be read at a meeting of Council, and also at the following meeting of the Society, and the ballot shall take place at the next following Ordinary Meeting of the Society. The assent of at least five-sixths of the number voting shall be requisite for the admission of a candidate.

Votes required to exclude.

Members shall sign laws.

XXIII. Every new Member or Associate shall receive due notice of his election, and be supplied with a copy of the obligation*, together with a copy of the Laws of the Society. He shall not be entitled to enjoy any privilege of the Society, nor shall his name be printed in the List of Members until he shall have paid his admission fee and first annual subscription, and have returned to the Secretaries the obligation signed by himself. He shall, at the first meeting of the Society at which he is present, sign a duplicate of the obligation in the Book of the Laws of the Society, after which he shall be introduced to the Society by the Chairman. No member or Associate shall be at liberty to withdraw from the Society without previously giving notice in writing to one of the Secretaries of his intention to withdraw, and returning all books or other property of the Society in his possession. Members and Associates will be considered liable for the payment of all

Conditions of Resignation.

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* The obligation referred to is as follows:—

ROYAL SOCIETY OF VICTORIA.

I, the undersigned, do hereby engage that I will endeavour to promote the interests and welfare of the Royal Society of Victoria, and to observe its laws, as long as I shall remain a Member or Associate thereof.

(Signed)

Address

Date

subscriptions due from them up to the date at which they give written notice of their intention to withdraw from the Society.

Honorary Members.

XXIV. Gentlemen not resident in Victoria, who are distinguished for their attainments in science, literature, or art, may be proposed for election as Honorary Members, on the recommendation of an absolute majority of the Council. The election shall be conducted in the same manner as that of Ordinary Members, but nine-tenths of the votes must be in favour of the candidate.

Subscriptions.

XXV. Ordinary Members of the Society shall pay two guineas annually, Country Members and Associates shall pay one guinea annually. Those elected after the first of July shall pay only half of the subscription for the current year. Ordinary Members may compound for all annual subscriptions of the current and future years by paying £21; and Country Members may compound in a like manner by paying £10 10s. Any Country Member having compounded for his subscription, and coming to reside within ten miles of Melbourne, must pay either the balance £10 10s. of the Ordinary Member's composition, or one guinea annually while he resides within ten miles of Melbourne. The subscriptions shall be due on the 1st of January in every year. At the commencement of each year there shall be hung up in the Hall of the Society a list of all Members and Associates, upon which the payment of their subscription as made shall be entered. During July, notice shall be sent to all Members and Associates still in arrears. At the end of each year, a list of those who have not paid their subscriptions shall be prepared, to be considered and dealt with by the Council.

Life Membership.

Entrance fees, etc.

XXVI. Newly-elected Ordinary and Country Members shall pay an entrance fee of two guineas, in addition to the subscription for the current year. Honorary Members, Corresponding Members and Associates shall not be required to pay any entrance fee. If the entrance fee and subscription be not paid with one month of the notification of election, a second notice shall be sent, and if payment

be not made within one month from the second notice, the election shall be void. Associates, on seeking election as Ordinary or Country Members, shall comply with all the forms prescribed for the election of Members, and shall pay the entrance fee prescribed above of Ordinary or Country Members respectively.

XXVII. At the Ordinary Meetings of the Society the chair shall be taken punctually at eight o'clock, and no new business shall be taken after ten o'clock. Duration of Meetings.

XXVIII. At the Ordinary Meetings business shall be transacted in the following order, unless it be specially decided otherwise by the Chairman:— Order and mode of conducting the business.

Minutes of the preceding meeting to be read, amended if incorrect, and confirmed.

New Members and Associates to enrol their names, and be introduced.

Ballot for the election of new Members or Associates.

Vacancies among officers, if any, to be filled up.

Business arising out of the minutes.

Communications from the Council.

Presents to be laid on the table, and acknowledged.

Motions, of which notice has been given, to be considered.

Notice of motion for the next meeting to be given in and read by one of the Secretaries.

Papers to be read.

XXIX. No stranger shall speak at a meeting of the Society unless specially invited to do so by the Chairman. Strangers.

XXX. Every paper before being read at any meeting must be submitted to the Council. Papers to be first laid before Council.

XXXI. The Council may call additional meetings whenever it may deem it necessary to do so. Additional Meetings.

XXXII. Every Member may introduce two visitors to the meetings of the Society by orders signed by himself. Visitors.

Members may read papers.

XXXIII. Members and Associates shall have the privilege of reading before the Society account of experiments, observations, and researches conducted by themselves, or original papers, on subjects within the scope of the Society, or descriptions of recent discoveries, or inventions of general scientific interest. No vote of thanks to any Member or Associate for his paper shall be proposed.

Or depute other Members.

XXXIV. If a Member or Associate be unable to attend for the purpose of reading his paper, he may delegate to any Member of the Society the reading thereof, and his right of reply.

Members must give notice of their papers.

XXXV. Any Member or Associate desirous of reading a paper, shall give in writing to one of the Secretaries, ten days before the meeting at which he desires it to be read, its title and the time its reading will occupy.

Papers by Strangers.

XXXVI. The Council may for any special reason permit a paper such as is described in Law XXXIII., not written by a member of the Society, to be read by one of the Secretaries or other Members.

Papers belong to the Society.

XXXVII. Every paper read before the Society shall be the property thereof, and immediately after it has been read shall be delivered to one of the Secretaries, and shall remain in his custody.

Papers must be original.

XXXVIII. No paper shall be read before the Society or published in the Transactions unless approved by the Council, and unless it consist mainly of original matter as regards the facts or the theories enunciated.

Council may refer papers to Members.

XXXIX. The Council may refer any paper to any Member or Members of the Society, to report upon the desirability of printing it.

Rejected papers to be returned.

XL. Should the Council decide not to publish a paper, it shall be at once returned to the author.

Members may have copies of their papers.

XLI. The author of any paper which the Council has decided to publish in the Transactions may have fifty copies of his paper on giving notice of his wish in writing to one

of the Secretaries, and any further number on paying the extra cost thereof.

XLII. Every Member and Associate whose subscription is not in arrear; and every Honorary and Corresponding Member is entitled to receive one copy of the Transactions of the Society as published. Newly-elected Members shall, on payment of their entrance fee and subscription, receive a copy of the volume of the Transactions last published. **Members and Associates to have Transactions.**

XLIII. Every book, phamphlet, model, plan, drawing, specimen, preparation, or collection presented to or purchased by the Society, shall be kept in the house of the Society. **Property.**

XLIV. The Library shall be open to Members and Associates of the Society, and the public, at such times and under such regulations as the Council may deem fit **Library.**

XLV. The legal ownership of the property of the Society is vested in the President, the Vice-Presidents, and the Treasurer for the time being, in trust for the use of the Society; but the Council shall have full control over the expenditure of the funds and management of the property of the Society. **Legal ownership of property.**

XLVI. Every Committee appointed by the Society shall at its first meeting elect a Chairman, who shall subsequently convene the Committee and bring up its report. He shall also obtain from the Treasurer such grants as may have been voted for the purposes of the Committee. **Committees elect Chairman.**

XLVII. All Committees and individuals to whom any work has been assigned by the Society shall present to the Council, not later than the 1st of November in each year, a report of the progress which has been made; and, in cases where grants of money for scientific purposes have been entrusted to them, a statement of the sums which have been expended, and the balance of each grant which remains unexpended. Every Committee shall cease to exist at the November meeting, unless then re-appointed. **Report before November 1st.**

Grants expire.

XLVIII. Grants of pecuniary aid for scientific purposes from the funds of the Society shall expire on the 1st of March next following, unless it shall appear by a report that the recommendations on which they were granted have been acted on, or a continuation of them be ordered by the Council.

Personal expenses not to be paid.

XLIX. In grants of money to Committees and individuals, the Society shall not pay any personal expenses which may be incurred by the Members.

Alterations of laws.

L. No new law, or alteration or repeal of an existing law, shall be made except at the Annual General Meeting in March, or at a Special General Meeting summoned for the purpose, as provided in Law XIX., and in pursuance of notice given at the preceding Ordinary Meeting of the Society.

Cases not provided for.

LI. Should any circumstance arise not provided for in these Laws, the Council is empowered to act as may seem to be best for the interests of the Society.

Corresponding Members.

LII. The Council shall have power to propose gentlemen not resident in Victoria, for election in the same manner as Ordinary Members, as Corresponding Members of the Society. The Corresponding Members shall contribute to the Society papers which may be received as those of Ordinary Members, and shall in return be entitled to receive copies of the Society's publications.

Privileges of Associates.

LIII. Associates shall have the privileges of Members in respect to the Society's publications, and at the Ordinary Meetings, with the exception, that they shall not have the power of voting; they shall also not be eligible as Officers of the Society.

MEMBERS

OF

The Royal Society of Victoria.

PATRON.

Hopetoun, His Excellency The Right Hon. John Adrian Louis Hope, G.C.M.G., Seventh Earl of.

HONORARY MEMBERS.

Agnew, Hon. J. W., M.E.C., M.D., Hobart, Tasmania.
Bancroft, J., Esq., M.D., Brisbane, Queensland.
Clarke, Colonel Sir Andrew, K.C.M.G., C.B., C.I.E., London.
Forrest, Hon. J., C.M.G., Surveyor-General, West Australia.
Hector, Sir James, K.C.M.G., M.D., F.R.S., Wellington, N.Z.
Liversidge, Professor A., F.R.S., University, Sydney.
Neumeyer, Professor George, Ph.D., Hamburg, Germany.
Russell, H. C., Esq., F.R.S., F.R.A.S., Observatory, Sydney, N.S.W.
Scott, Rev. W., M.A., Kurrajong Heights, N.S.W.
Todd, Charles, Esq., C.M.G., F.R.A.S., Adelaide, S.A.
Verbeek, Dr. R. D. M., Buitenzorg, Batavia, Java.

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Strettle, W. S., Esq., Ormond College, Carlton.

Tate, Frank, Esq., B.A., Training College, Grattan-street.
Tipping, Isaac, Esq., C.E., Windsor.

Wilsmore, C. N., Esq., B.Sc., University, Melbourne.

LIST OF THE INSTITUTIONS AND LEARNED SOCIETIES THAT RECEIVE COPIES OF THE "TRANSACTIONS AND PROCEEDINGS OF THE ROYAL SOCIETY OF VICTORIA."

ENGLAND.

Agent-General of Victoria	London
Anthropological Institute	London
Biological Society of Liverpool	Liverpool
Bodleian Library	Oxford
British Museum	London
Colonial Office Library	London
"Electrician"	London
Foreign Office Library	London
Free Public Library	Liverpool
Geological Society	London
Institute of Mining and Mechanical Engineers ...	Newcastle
Institution of Civil Engineers	London
Linnæan Society	London
Literary and Philosophical Society	Liverpool
Literary and Philosophical Society	Manchester
Manchester Museum, Owens College ...	Manchester
Marine Biological Laboratory	Plymouth
Natural History Museum	London
Naturalists' Society	Bristol
"Nature"	London
Owens College Library	Manchester
Patent Office, 25 Southampton Buildings ...	London
Philosophical Society	Cambridge
Royal Asiatic Society	London
Royal Astronomical Society	London
Royal Colonial Institute	London
Royal Gardens	Kew
Royal Geographical Society	London
Royal Microscopical Society	London
Royal Society	London
Statistical Society	London
University Library	Cambridge

SCOTLAND.

Botanical Society	Edinburgh
Geological Society	Edinburgh
Royal College of Physicians' Laboratory	Edinburgh
Royal Observatory	Edinburgh
Royal Physical Society	Edinburgh
Royal Society	Edinburgh
Royal Scottish Society of Arts	Edinburgh
Scottish Geographical Society	Edinburgh
University Library	Edinburgh
University Library	Glasgow

IRELAND.

Natural History and Philosophical Society ...	Belfast
Royal Dublin Society	Dublin
Royal Geological Society	Dublin
Royal Irish Academy	Dublin
Trinity College Library	Dublin

GERMANY.

Gessellschaft für Erdkunde	Berlin
Grossh. Hessische Geologische Anstalt	Darmstadt
Königl. Botanische Gesellschaft...	Regensburg
Königl. Offentl. Bibliothek	Dresden
Königl. Preussische Akademie der Wissenschaften ...	Berlin
Königl. Sächs Gesellschaft der Wissenschaften ...	Leipzig
Königl. Societät der Wissenschaften	Göttingen
Naturforschende Gesellschaft	Emden
Naturforschende Gesellschaft	Halle
Naturforschende Gesellschaft	Leipzig
Naturhistorisch Medizinischer Verein	Heidelberg
Naturhistorisches Museum	Hamburg
Naturhistorisches Museum	Hanover
Naturwissenschaftlicher Verein...	Bremen
Naturwissenschaftlicher Verein...	Frankfurt
Oberhessische Gesellschaft für Natur & Heilkunde ...	Giessen
Schlesische Gesellschaft für Vaterländ. Cultur ...	Breslau
Verein für Erdkunde	Darmstadt
Verein für Erdkunde	Halle
Verein für Naturkunde	Kassel

AUSTRIA.

Imperial Observatory	Prague
K. K. Akademie der Wissenschaften	Wien